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THESIS

REQUIREMENT VERIFICATION AND SYSTEMS ENGINEERING TECHNICAL REVIEW (SETR) ON A COMMERCIAL DERIVATIVE AIRCRAFT (CDA) PROGRAM

by

Theresa L. Thomas

September 2017

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The Naval Air Systems Command (NAVAIR) systems engineering technical review (SETR) process does not acknowledge commercial documentation of military commercial derivative aircraft (CDA) programs. The Federal Aviation Administration's (FAA) type certificate (TC) process is for airworthiness only, but is extensive. This thesis compares the NAVAIR SETR timeline to the FAA TC process by phase. The majority of the FAA TC process effort occurs in the implementation phase, which maps to test readiness review (TRR), flight readiness review (FRR), functional configuration audit (FCA), and system verification review (SVR). These events assess requirement verification planning and results, inclusive of airworthiness and performance requirements. The products of this thesis are diagrams mapping the commercial documents of the implementation phase to the SETR entrance criteria of these events. Out of 30 evaluated SETR entrance criteria, 22 map to FAA elements. A case study of a military CDA program, the Presidential Helicopter Replacement Program, evaluates the timeline comparison and validates applicability of the mapping diagrams. Mapping of the remaining SETR events would enable further benefits. A reinstatement and rewrite of the cancelled NAVAIRINST 13100.15, Engineering Technical Review of Commercial-Derivative Aircraft Programs, would restore NAVAIR policy on supporting military CDA programs and their efficiencies with SETR.

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REQUIREMENT VERIFICATION AND SYSTEMS ENGINEERING TECHNICAL REVIEW (SETR) ON A COMMERCIAL DERIVATIVE AIRCRAFT (CDA) PROGRAM

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Submitted in partial fulfillment of the
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ABSTRACT

The Naval Air Systems Command (NAVAIR) systems engineering technical review (SETR) process does not acknowledge commercial documentation of military commercial derivative aircraft (CDA) programs. The Federal Aviation Administration's (FAA) type certificate (TC) process is for airworthiness only, but is extensive. This thesis compares the NAVAIR SETR timeline to the FAA TC process by phase. The majority of the FAA TC process effort occurs in the implementation phase, which maps to test readiness review (TRR), flight readiness review (FRR), functional configuration audit (FCA), and system verification review (SVR). These events assess requirement verification planning and results, inclusive of airworthiness and performance requirements. The products of this thesis are diagrams mapping the commercial documents of the implementation phase to the SETR entrance criteria of these events. Out of 30 evaluated SETR entrance criteria, 22 map to FAA elements. A case study of a military CDA program, the Presidential Helicopter Replacement Program, evaluates the timeline comparison and validates applicability of the mapping diagrams. Mapping of the remaining SETR events would enable further benefits. A reinstatement and rewrite of the cancelled NAVAIRINST 13100.15, *Engineering Technical Review of Commercial-Derivative Aircraft Programs*, would restore NAVAIR policy on supporting military CDA programs and their efficiencies with SETR.

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	advisory circular
AQP	airworthiness qualification plan
ATC	amended type certificate
CDA	commercial derivative aircraft
CDR	critical design review
CDRL	contract deliverable
CFR	Code of Federal Regulations
CM	configuration management
CP	certification plan
CPP	certification project plan
CSI	critical safety item
DOD	Department of Defense
DON	Department of Navy
E3	electromagnetic environmental effects
EMD	engineering and manufacturing development
ICA	instructions for continued airworthiness
IFC	interim flight clearance
IMS	integrated management schedule
FAA	Federal Aviation Administration
FCA	functional configuration audit
FRR	flight readiness review
GFE	government furnished equipment
JSSG	joint service specification guide
M&S	modeling and simulation
MCDA	military commercial derivative aircraft
MCO	Military Certification Office
MIL-HDBK	military handbook
NATOPS	Naval Air training and operating procedures
NAVAIR	Naval Air Systems Command
NAVAIRINST	NAVAIR instruction

PCA	physical configuration audit
PFC	permanent flight clearance
PDR	preliminary design review
PSCP	project specific certification plan
RTCA	Radio Technical Commission for Aeronautics
SETR	systems engineering technical review
SFR	system functional review
SIL	simulation lab
SOF	safety of flight
SRR	system requirements review
STC	supplemental type certificate
SVR	system verification review
TC	type certificate
TCBM	type certification board meeting
TCDS	type certificate data sheet
TIA	type inspection authorization
TIR	type inspection report
TRR	test readiness review
UAS	unmanned aviation system
USC	United States Code
V&V	verification and validation

EXECUTIVE SUMMARY

The Under Secretary of Defense (AT&L) directs using commercial products and processes where possible to reduce cost and time to execute military acquisition programs (2003). Naval Air Systems Command (NAVAIR) certifies airworthiness and evaluates performance, being the military airworthiness authority and the procuring customer. The Federal Aviation Administration (FAA) only certifies civil airworthiness, but reviews a great deal of performance in the process of ensuring performance does not negatively affect airworthiness (U.S. Department of Transportation Federal Aviation Administration 2007). The FAA requires full compliance to its safety standards, while NAVAIR allows levels of safety risk with acceptance at increasing authority levels (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016). This provides the opportunity for leveraging NAVAIR's acceptance of performance requirements through the FAA's acceptance of airworthiness requirements.

The NAVAIR systems engineering technical review (SETR) process is baselined to a full developmental military program, with programs tailoring down as appropriate. There is no acknowledgement of commercial processes or documentation in the NAVAIR SETR process document, NAVAIRINST 4355.19 (2015). The NAVAIR Airworthiness and CYBERSAFE Directorate (AIR-4.0P) explicitly accepts FAA airworthiness certifications without additional technical review (2016). Accepting already-executed FAA processes in SETR reviews would leverage further the value added of commercial derivative aircraft (CDA) program cost efficiencies by avoiding extraneous, duplicative effort during program execution. The benefit to NAVAIR SETR test readiness review (TRR), flight readiness review (FRR), functional configuration audit (FCA), and system verification review (SVR) is provided by mapping FAA processes and documentation to SETR entrance criteria. These four SETR events focus on requirement verification planning and evaluation, where the majority of the FAA type certificate (TC) process effort aligns with NAVAIR SETR efforts. By identifying FAA elements that map to NAVAIR SETR entrance criteria, military CDA programs can reduce SETR and program execution

effort by acknowledging and accepting the FAA elements instead of requiring duplicative effort to NAVAIR standards.

This research is empirical, examining existing documentation and guidance. The primary sources of data are NAVAIRINST 4355.19 for the SETR process and FAA Order 8110.4 for the TC process. NAVAIRINST 13100.15 is a cancelled instruction that provided a poor comparison of the FAA TC process to NAVAIR technical reviews; this instruction is highly relevant to this thesis, but disappointing in its execution (2002). Discussion of requirement definition documents for NAVAIR and the FAA frames the difference in focus and confusion of airworthiness versus performance requirement definitions. The remaining documents discussed are pertinent to NAVAIR and FAA airworthiness definitions.

A side-by-side comparison of the NAVAIR SETR timeline and the FAA TC process at a high level provides a direct correlation between the two. This overall timeline comparison is then broken into phases. The phase comparisons align FAA elements to NAVAIR SETR events. This enables the creation of mapping diagrams, relating FAA elements to specific SETR entrance criteria. The final products of this thesis are mapping diagrams for TRR, FRR, FCA, and SVR. While the FAA elements cannot completely satisfy any given entrance criteria due to NAVAIR SETR assessing a much broader scope, there is no question of benefit. For TRR, eight out of eleven entrance criteria mapped to FAA elements; for FRR, seven out of ten; for FCA, four out of five; and for SVR, three out of four. Out of 30 evaluated SETR entrance criteria, 22 map to FAA elements; this is over 73%. This high ratio proves there is benefit in accepting FAA processes and documentation for military CDA programs, even with FAA elements providing partial satisfaction to the SETR entrance criteria.

This thesis presents a use case study on the Presidential Helicopter Replacement Program. This is a military CDA program obtaining an FAA airworthiness certificate to the maximum extent possible, inclusive of the military modifications (NAVAIR 2016). Scoping SETR for this program to integration of new and modified design supports the acquisition strategy of accepting the baseline performance of the commercial S-92A. The NAVAIR SETR timeline to FAA TC process comparison for this program changes from the original analysis. This program entered at Milestone B, requiring the FAA TC process

to fit entirely within the engineering and manufacturing development (EMD) phase. The NAVAIR SETR events also shift to accommodate the Milestone B entry. This maintains the original alignment of FAA elements to SETR events and the correlation remains unchanged. The SETR entrance criteria mapping diagrams remain valid and relevant for this program. The majority of requirements for this program, 67%, are verifiable by the time of the FAA TC release, ensuring the SETR entrance criteria mapping provides great potential in reducing the effort of evaluation.

Recommendations include revitalizing NAVAIRINST 13100.15, and acknowledgement of FAA elements for military CDA programs within NAVAIRINST 4355.19. Mapping the remainder of SETR events would identify additional benefits.

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I. INTRODUCTION

The differences between airworthiness and performance requirements affect requirements development and requirements verification. Civil aviation and military acquisition approach these areas differently. In the case of a military commercial derivative program, the military technical review process should acknowledge civil processes to leverage additional benefits. This chapter also describes the scope, methodology, and organization of this thesis.

A. BACKGROUND

The evaluation of airworthiness and performance requirements is often confused and blurred; the focus is different, yet there can be overlap (see Figure 1). The relative size and overlap area of the airworthiness and performance sets will vary depending on the program. Will the system be safe to fly? How well will it perform? These are two very different questions. For example, a radio's transmissions must not cause interference with the flight control computer's operations, but whether that radio transmits at the minimum required range is a separate determination. The evaluation of a requirement may address airworthiness or performance, or both at the same time.
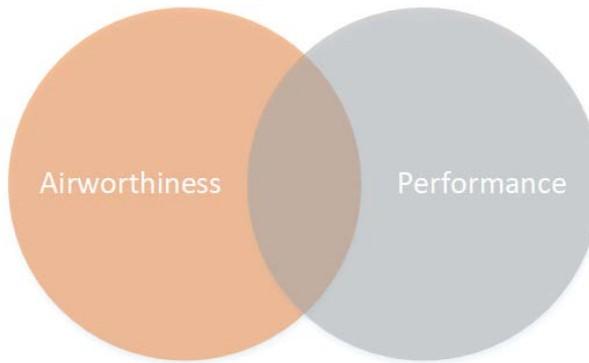

Figure 1.   Requirement Venn Diagram

Requirements development for a program considers both airworthiness and performance. Performance requirements derive from the mission requirements that drive

the need for the program's creation. Airworthiness requirements ensure an aircraft is capable of safe take-off, flight and landing; the safety-of-flight (SOF) assessment determines the associated levels of safety risk (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016). When evaluating an aircraft design's compliance to requirements, performance verification often requires flight-testing; but an aircraft must be safe to fly prior to allowing that flight test to occur. Assessments then occur in phases, first verifying airworthiness in order to execute flight test, then evaluating performance requirements. Flight tests may occur in incremental stages, with reduced limitations imposed until the final collection of sufficient data to validate safe expansion to the full requested performance.

The Department of Defense (DOD) has been shifting to use of commercial products and processes where possible, to reduce costs and time needed to acquire products (Under Secretary of Defense [AT&L] 2003). Commercial derivative aircraft (CDA) programs can provide a great savings in both, when it is possible to use a commercial platform in a military application with minimized modifications. Implementing systemic change to support this type of program requires a great deal of effort and is an on-going effort (Lucka 2003). Today, the Naval Air Systems Command (NAVAIR) Systems Engineering Technical Review (SETR) process does not take advantage of already-exercised processes for commercial derivative programs, requiring a full and comprehensive assessment against NAVAIR standards.

NAVAIR evaluates both airworthiness and performance, being both the airworthiness authority and the customer; the Federal Aviation Administration (FAA) only certifies airworthiness, leaving performance acceptance to the commercial customer (U.S. Department of Transportation Federal Aviation Administration 2007). Nevertheless, the FAA assesses all performance requirements for potential to affect airworthiness, and assesses airworthiness with the system operating as intended. As a result, the FAA evaluates most performance requirements as part of the airworthiness certification. The FAA's charter, defined by 49 U.S.C. § 44701, is to "promote safe flight of civil aircraft in air commerce" by enforcing regulations defining "minimum standards required in the interest of safety," aircraft must meet these regulations, with no increase in safety risk

tolerated. NAVAIR's military airworthiness and SOF requirements focus on the integrity of the aircraft itself and allow for increasing levels of safety risk, with acceptance at increasing authority levels (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016). These different approaches result in NAVAIR having a narrower scope of airworthiness requirements in comparison to the FAA, as shown in Figure 2. Therefore, the FAA has a high likelihood of assessing what NAVAIR would consider a performance-only requirement as part of the FAA airworthiness assessment. The remaining performance requirements are the few the FAA would not consider affecting airworthiness and those the FAA cannot certify for pure military, non-civil applications.
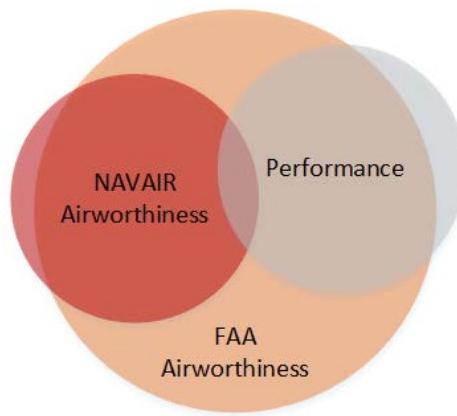
Figure 2.   NAVAIR vs. FAA Requirements Venn Diagram

B.   PROBLEM

The NAVAIR SETR process does not take full advantage of potential efficiencies by accepting existing commercial FAA certifications and processes; acknowledgement and referencing of these processes and relevant documents is completely lacking. The NAVAIR SETR process establishes event-driven, independent technical reviews, defining entrance criteria, documentation required, and questions to evaluate technical readiness for the event (NAVAIR 2015b). A full developmental military program is the baseline, with programs tailoring the SETR event as appropriate.

The Department of Navy (DON) Airworthiness and CYBERSAFE Directorate (AIR-4.0P) does acknowledge commercial processes to leverage an airworthiness assessment (2016). The SETR process does not reference the airworthiness process even though airworthiness products are among SETR event entrance criteria. While NAVAIR executes both SETR and airworthiness processes according to these instructions, there is a missing link between them; such a linkage would open the door to a common acceptance of commercial processes. The SETR process could gain additional benefits in requirements verification planning and evaluation assessments. Understanding and acceptance of already-executed FAA processes would help to leverage further the value added of CDA program cost efficiencies by avoiding extraneous, duplicative effort during the SETR process. This thesis investigates the following research questions:

- What is the benefit to NAVAIR SETR execution on CDA programs by considering FAA processes and documentation?

- For requirements verification planning, how do FAA processes and documentation for test readiness and flight readiness map to NAVAIR SETR Test Readiness Review (TRR) and Flight Readiness Review (FRR) entrance criteria?

- For requirements verification acceptance, how do FAA performance evaluations map to NAVAIR SETR Functional Configuration Audit (FCA) and System Verification Review (SVR) entrance criteria?

There are additional SETR events that would also benefit, but this thesis will remain focused on these four events. The majority of efficiency will be here.

Conducting the SETR process takes a great deal of effort, and tailoring to a unique program is difficult and subjective, with criteria written to a full-development Government program and no references to commercial equivalent terminology or processes. By evaluating the similarities and differences, this thesis provides a comparison of NAVAIR and FAA processes, providing guidance on reducing effort and potentially program cost for TRR, FRR, FCA, and SVR.

C.   SCOPE AND METHODOLOGY

This thesis focuses on manned aircraft typical for a military commercial derivative program. Balloons, light-sport aircraft, amateur-built aircraft and similar are under the

purview of the FAA, but not discussed within this thesis. Unmanned aviation systems (UASs) bring their own additional unique considerations, with multiple levels of criteria based on the complexity of the system and physical size of the vehicle. Assessing the additional ramifications of UAS programs is also beyond the scope of this thesis.

The research is empirical, examining existing documentation and guidance. Each document review determines how the FAA and NAVAIR cover the material. A side-by-side layout of process flow, at an overall high level, and then broken down to segmented lower levels, provides a direct correlation between NAVAIR and FAA milestones. This correlation leads to SETR event specific diagrams, and a mapping of TRR, FRR, FCA and SVR entrance criteria to FAA processes and documentation (Figure 3). A pertinent case study, the new Presidential Helicopter Replacement Program, determines the value of the benefits identified.
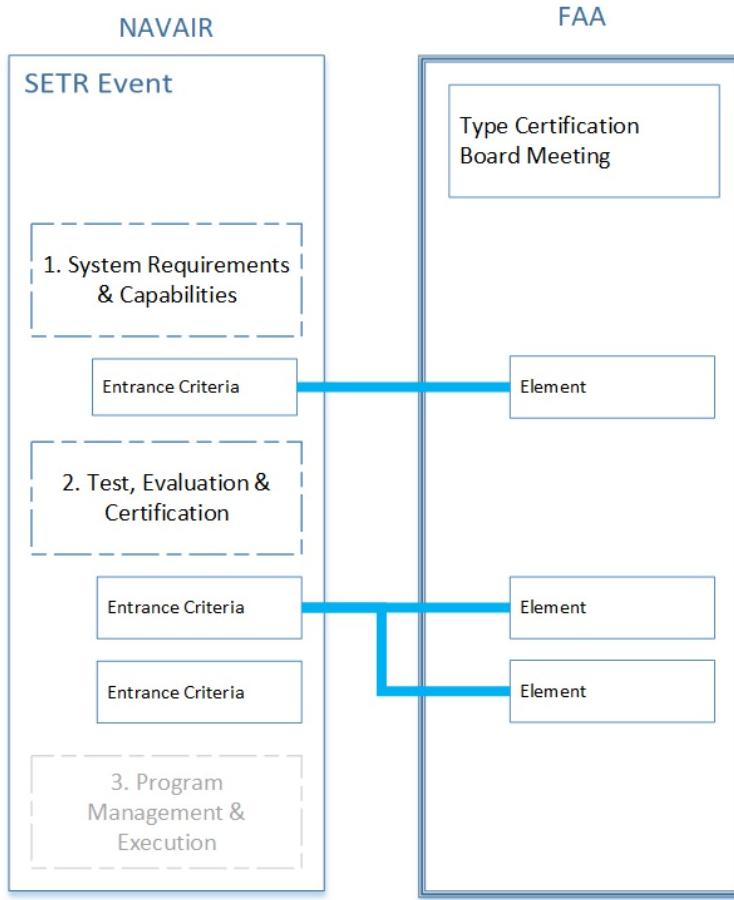
Figure 3.   SETR Entrance Criteria to FAA Element Mapping Product

D.   ORGANIZATION OF THESIS

This thesis is divided into five chapters, opening with an introduction, background, objectives, scope, methodology, and process discussion. The document review is fundamental to the research of this paper; key documents are discussed, providing the raw material for the analysis. The analysis chapter then compares NAVAIR data to FAA data: airworthiness similarities/differences, process timeline comparisons from a high level to a low level are the key tool in enabling the mapping correlation, and then the mapping correlations for the TRR, FRR, FCA, and SVR SETR events. The fourth chapter discusses a case study, the Presidential Helicopter Replacement Program, presenting lessons learned and assessing the benefits of the mapping diagrams previously presented. The final chapter contains the conclusions and recommends areas for further research.

II. DOCUMENTATION REVIEW

A research review found only one relevant piece of existing research directly applicable to the topic of this thesis, a previous thesis on improving the NAVAIR flight clearance process for CDA programs (Lucka 2003). No other published literature or theses reviewed discuss SETR and commercial processes, or airworthiness in comparison to performance assessments. Examination of the existing documents for NAVAIR and the FAA pertinent to the processes in question remains the best option for review.

This chapter has two major sections, the first on NAVAIR documentation, and the second on FAA documentation. Each section discusses key documents and presents key points and data for later analysis.

A. EXISTING PROCESSES, NAVAIR

As the focus of this thesis is to determine benefits to NAVAIR processes, this chapter discusses relevant NAVAIR documents first. Figure 4 provides a visual of the documents reviewed, categorized as requirement or procedural defining.

Requirements

MIL-HDBK-516 Airworthiness Certification Criteria	Joint Service Specification Guides

NAVAIRINST 13100.15 Engineering Technical Review of Commercial-Derivative Aircraft Programs	NAVAIRINST 4355.19 Systems Engineering Technical Review Process	NAVAIRINST 13034.1 Flight Clearance Policy for Air Vehicles and Aircraft Systems

Procedures

Figure 4.   NAVAIR Documentation

1. **NAVAIRINST 13100.15,** *Engineering Technical Review of Commercial-Derivative Aircraft Programs*

The subject of this instruction directly relates to the topic of this thesis, leveraging commercial process for engineering technical reviews. This instruction directs the leveraging of commercial processes in a CDA program. A review of the content reveals it is lacking in specific guidance and discussion of commercial processes as well as their correlation to NAVAIR reviews.

This document creates and defines "program points" at critical junctures in a CDA program's execution (NAVAIR 2002). These points correlate to acquisition development milestones, but are unique terminology to this instruction. Figure 5 graphically compares these program points to two SETR events, Preliminary Design Review (PDR) and Critical Design Review (CDR), and the FAA Type Certificate (TC)/Supplemental Type Certificate (STC) process. While specific FAA forms are referenced within this figure, no FAA documents are cited anywhere in the instruction, leaving the reader completely without references to full details.
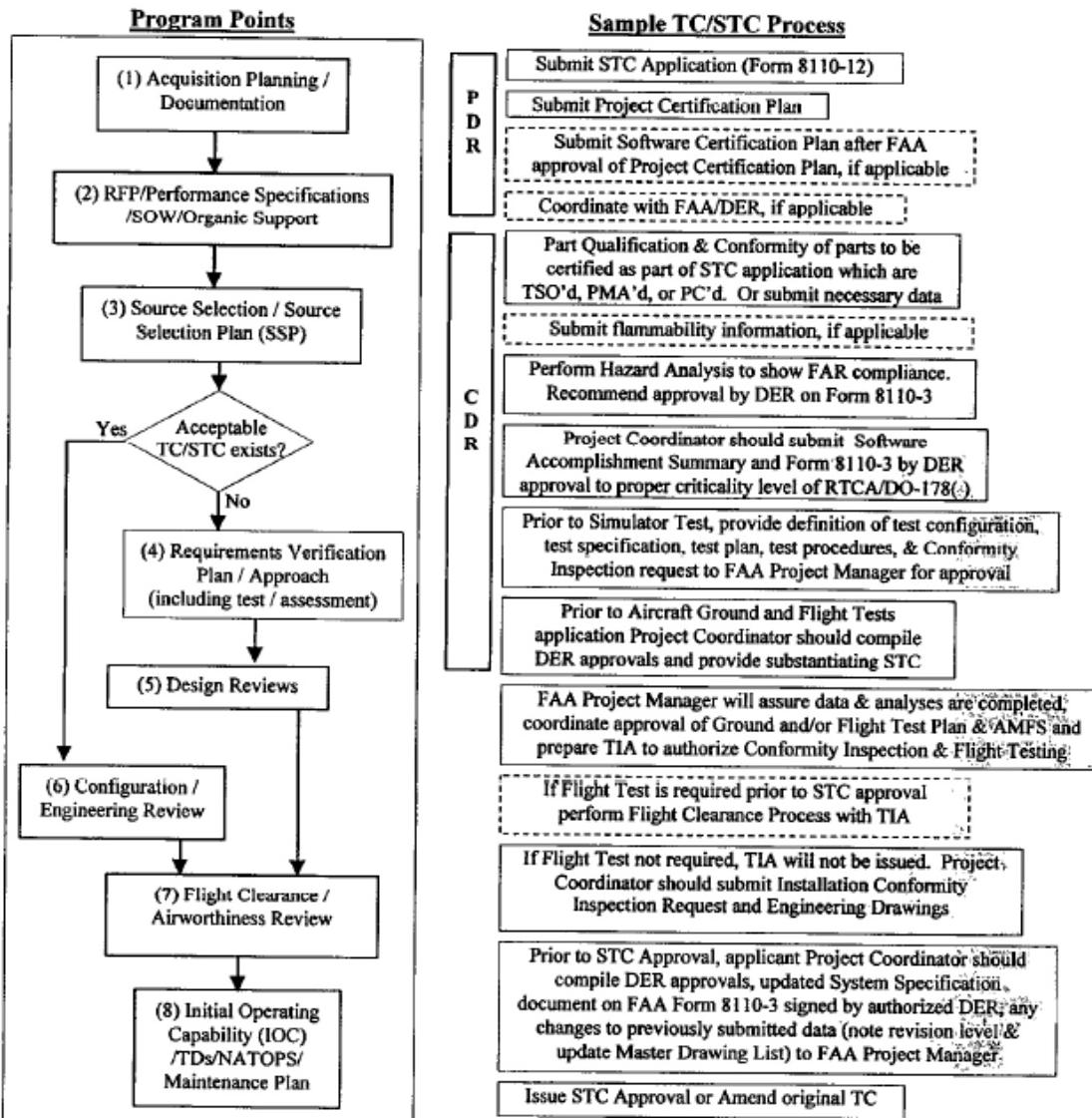
Figure 5.   New Aircraft Acquisition or Major Modifications Program Point Process Flow.
Source: NAVAIR (2002).

The NAVAIR airworthiness instruction references NAVAIRINST 13100.15 (NAVAIR 2016a). This referencing is inaccurate though, as within the past few years a cancellation of NAVAIRINST 13100.15 occurred with no replacement or explanation. Lucka was hopeful the policy in this instruction would help to initiate a paradigm shift, but he noted its lack of detail and specifics for execution (Lucka 2003). The creation of terms not used elsewhere in acquisition or product development in conjunction with the vague and short discussion of alignment to incompletely referenced commercial processes, lead

to a crippling ability of this instruction being useful. In spite of its unique nature and open pursuit of supporting commercial processes, these flaws potentially led to its lack of use and ultimate demise.

2. NAVAIRINST 4355.19, *Systems Engineering Technical Review Process*

This document is the defining instruction for the NAVAIR SETR process. Independent boards assess a program's technical status for development, design maturity, and risks (NAVAIR 2015b). This instruction discusses the tailoring process, minimum recommended reviews, and the requirement to complete a checklist for each review. An enclosure provides each review's entrance criteria. A separate handbook provides additional guidance on review descriptions, suggested agenda, and timing (NAVAIR 2015a).

There are four reviews evaluating requirements verification planning and compliance assessment: TRR, FRR, FCA, and SVR (NAVAIR 2015a). TRRs focus on ensuring the design baseline is stable, requirements traced to test planning efforts, and resource availability needed to conduct testing. FRRs assess similar elements as a TRR, but are specific to preparing for flight in support of testing and include a check on airworthiness and flight clearance status. As a data audit and not a review event, FCAs validate the design satisfies the functional requirements. Often in conjunction with an FCA, an SVR provides the review structure for the audit results as well as any associated risk assessments for incomplete or non-compliant findings. See Figure 6 for the graphic of the SETR timeline to see the relationship of these events to each other and the entire acquisition timeline (NAVAIR 2015b).
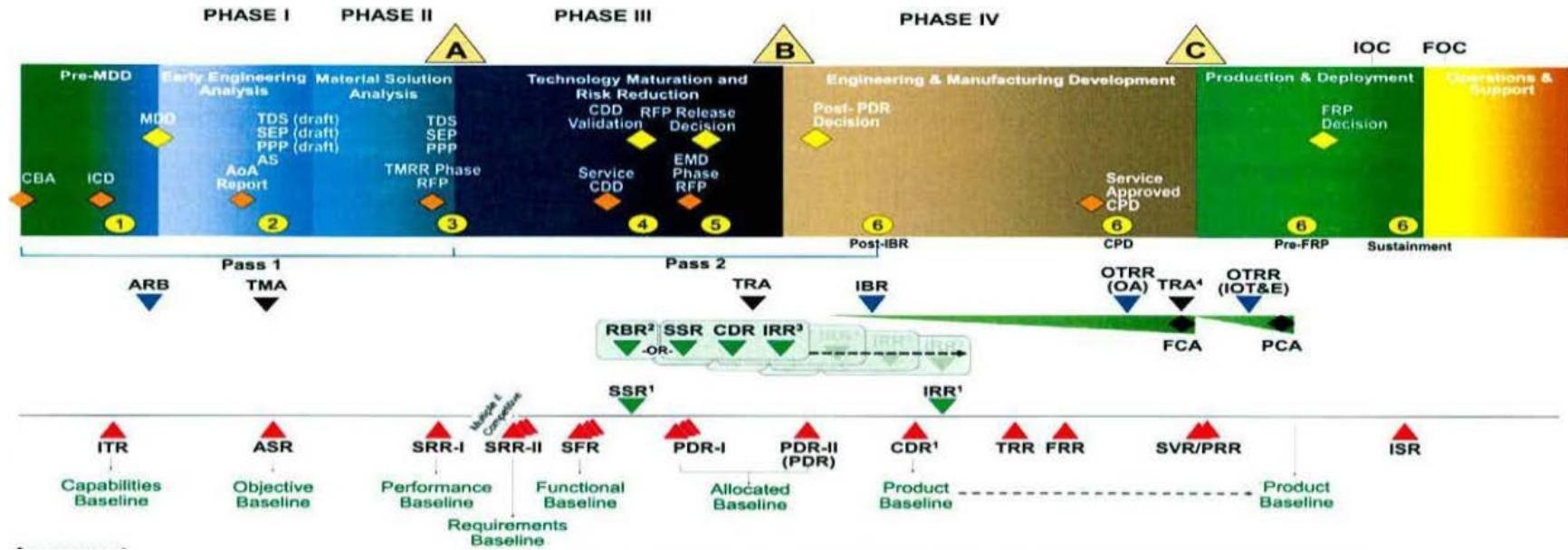
Figure 6.   NAVAIR System Engineering Technical Review Timeline.
Adapted from NAVAIR (2015b).

The potential for leveraging commercial or FAA processes is discussed nowhere in the instruction nor the handbook. There are no explicit considerations or provisions for CDA programs.

3.   **NAVAIRINST 13034.1,** *Airworthiness and Cybersecurity Safety Policies for Air Vehicles and Aircraft Systems*

This document defines the policy and provides instructions for executing and managing airworthiness of NAVAIR programs (NAVAIR 2016a). Two definitions are critical to this instruction and this thesis:

> Assessment of the airworthiness of an air system configuration determines its ability to safely attain, sustain and terminate flight ("complete" in case of UAS) per approved usage limits. … Assessment of Safety of Flight (SOF) determines the property of an air system configuration to safely attain, sustain, and terminate or complete flight (to include in-flight or post-flight aircrew survivability), within prescribed and accepted limits for injury or death to personnel, damage to equipment, property, and/or environment. The intent of assessing SOF is to show that the level of system safety risk (hazards resulting in death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment) have been appropriately identified by the Technical Area Experts (TAE), accepted by the appropriate authority, and concurred with by the fleet or test user for high and serious risks. (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016, 1-2, 1-3)

The instruction defines six tenets key to establishing and maintaining airworthiness:

1.   Continuing Airworthiness: ensure sustainment of airworthiness through the entire life cycle.

   a. Configuration Management: ensure processes are in place to manage and control changes, assessing airworthiness impacts of those changes.

   b. Maintenance: ensure procedures are in place for repairs and sustainment of airworthiness.

   c. Material Management: ensure processes are in place to authorize manufacturers, screen for counterfeits, and impose extra rigor on parts affecting safety.

2.   Training Systems/Devices: align curricula and simulators with the aircraft configuration to ensure proper training of aircrew and maintainers.

3. Safety Management: assess safety risks, mitigate where possible, document and obtain acceptance when risk level is above normal for the mission.

4. Flight Tests: establish incremental envelope expansion criteria, collecting data by flight test.

5. SETR: include a process check to ensure programmatic pressures do not negatively affect airworthiness.

6. Airworthiness Certification Products: release documentation certifying an airworthiness and SOF assessment.

The last tenet, airworthiness certification products, is an assurance of a thorough, independent technical review for both airworthiness and SOF, as well as the identification and acceptance of safety risks. The interim flight clearance (IFC) is temporary, for a specific configuration and with a defined condition and/or date for expiration. An IFC may or may not flow into a permanent flight clearance (PFC), a configuration controlled and regularly updated operator's manual.

This instruction explicitly acknowledges and recognizes airworthiness certifications issued by the FAA, and in fact directs full acceptance of these certifications; no engineering review of the FAA's work or supporting documentation is required. For CDA, basing NAVAIR IFCs and PFCs entirely on FAA Type Inspection Authorizations (TIAs), TCs, or STCs is acceptable. Directing acceptance of these FAA certifications is a significant change in the desired direction since the time of Lucka's thesis, when this instruction only recommended use of FAA data, which NAVAIR engineering did not understand nor support (Lucka 2003). Understanding the application of these certifications to the NAVAIR program is fundamental, and NAVAIR must assess any modifications outside of or impactful to the FAA certification.

This instruction provides the overall framework for NAVAIR's airworthiness definitions, processes, concerns, and responsibilities. Its acknowledgement and direct acceptance of FAA airworthiness products benefits CDA programs.

4. MIL-HDBK-516 Department of Defense Handbook, *Airworthiness Certification Criteria*

By subsystem or discipline, this handbook defines explicit airworthiness certification criteria, identifying standards and methods of compliance for each (Department of Defense 2014). These criteria create the airworthiness certification basis for each military service's airworthiness authority. The handbook allows for tailoring, whether additive or subtractive, and discusses methods to document such tailoring. CDA programs and FAA airworthiness certification is explicitly acknowledged and discussed to a limited extent.

NAVAIRINST 13034.1 references this handbook in several places: a policy paragraph recommending the development of an airworthiness qualification plan (AQP), stating MIL-HDBK-516 "should" be used; in the responsibilities chapter, directing integration of this handbook into airworthiness requirements; and in the chapter discussing flight operating limitations, as a reference providing detailed data requirements (NAVAIR 2016a). In FAA Order 8110.101, the FAA states modifications for military commercial derivative aircraft (MCDA) that cannot meet civil criteria must meet the criteria in this handbook, further discussing its definitive use by the military (2015).

5. Joint Service Specification Guides (JSSGs)

The DOD uses the suite of JSSG documents as a basis to develop performance requirements for aircraft (Department of Defense 2004). These documents provide a template for individual requirement language, rationale to justify the requirement, verification considerations, and lessons learned from past programs. The JSSGs do not use the word "airworthiness," or reference MIL-HDBK-516. The only assessment involving safety for flight readiness is identification of safety hazards in the context of system safety, not airworthiness (Department of Defense 2004).

The seam between airworthiness and performance requirement development could greatly benefit by an open acknowledgement and cross-referencing, avoiding potential overlap or conflicting requirements. Requirements developed from the JSSGs could also affect airworthiness or SOF.

B.   EXISTING PROCESSES, FAA

This section discusses FAA documents relevant to this thesis. Figure 7 provides a visual of these documents, categorized as regulation, procedural or guidance. This section discusses many of these documents in general and not in specific; showing them here provides additional context.
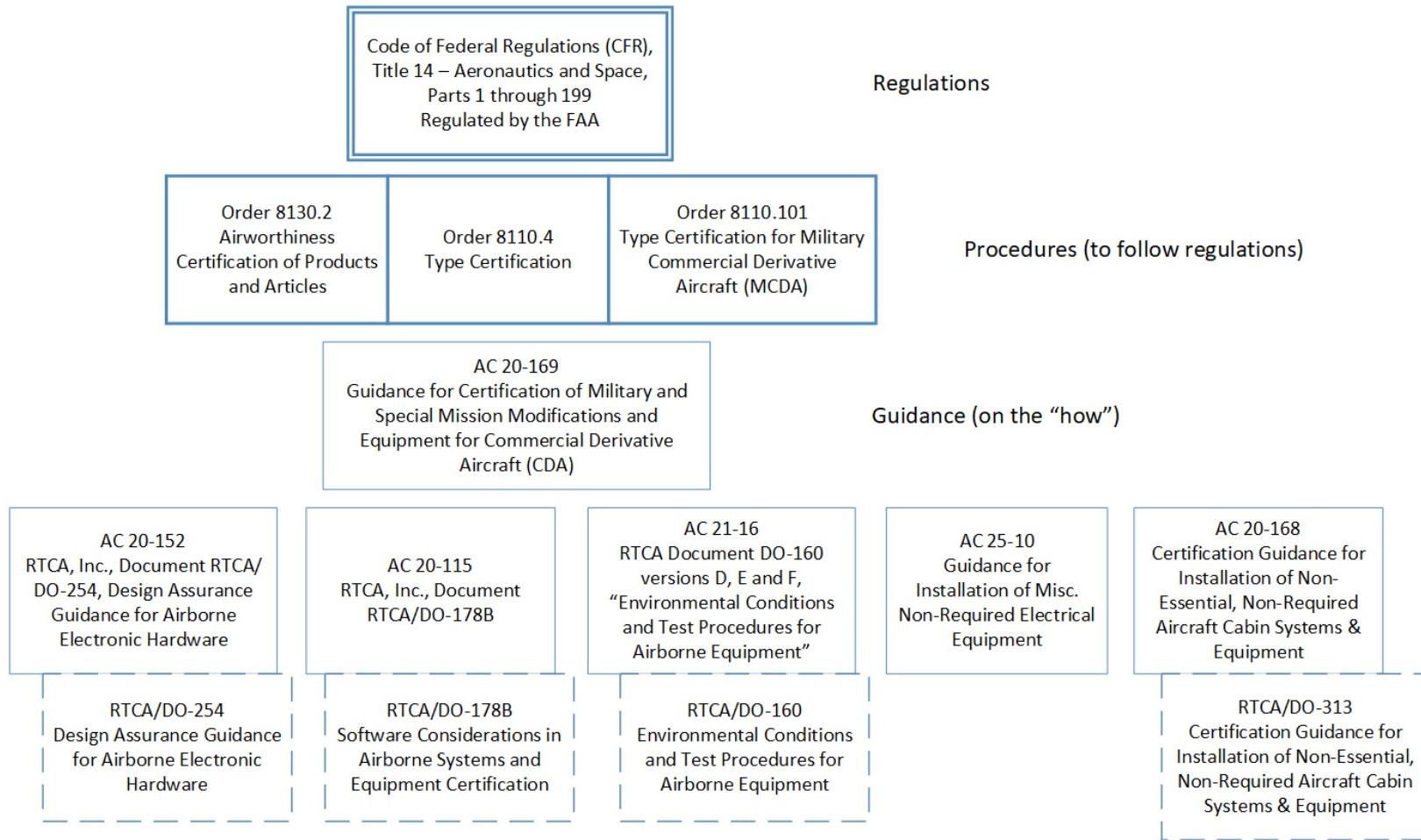
Figure 7.   FAA Documentation

1. Civil Document Structure

The general structuring of the discussed civil documents is hierarchical. The Title 14 Code of Federal Regulations (CFR) is law and contains the detailed regulations for minimum aircraft requirements. FAA Orders provide the procedures to implement the CFR. The FAA also issues advisory circulars (ACs), which align to the CFR, and provide guidance on how to show compliance. In many instances, the FAA ACs allow use of Radio Technical Commission for Aeronautics (RTCA) documentation as one way to show compliance to the specified regulations discussed in the AC.

2. 14 CFR

Title 14 of the CFR covers aeronautics and space; the FAA regulates parts 1 through 199. Parts 1 through 49 address aircraft, and parts 91 through 97 address air traffic and general operating rules. The remaining parts address topics not of interest to this thesis, such as air carrier operations, airport operations, air traffic rules, training device qualification, crewmember certification, and administrative procedures. These regulations define the minimum standards established by the FAA to ensure safe flight of civil aircraft, as directed by 49 U.S.C. § 44701.

3. Order 8130.2, *Airworthiness Certification of Products and Articles*

This document defines the policy and provides instructions for executing and managing airworthiness of FAA programs (U.S. Department of Transportation Federal Aviation Administration 2015a). The definition of airworthiness with two criteria is critical to this instruction and this thesis. Meeting both conditions is required:

> The aircraft must conform to its type design. For the purpose of airworthiness, conformity to the type design is considered attained when the aircraft configuration and the engine, propeller, and articles installed are consistent with the drawings, specifications, and other data that are part of the type certificate (TC). This includes any supplemental type certificate (STC) and repairs and alterations incorporated into the aircraft.
>
> The aircraft must be in a condition for safe operation. This refers to the condition of the aircraft relative to wear and deterioration, for example, skin corrosion, window delamination/crazing, fluid leaks, and tire wear. (U.S. Department of Transportation Order 8130.2 2015, 2-1)

This order defines the content and details of forms for airworthiness applications and certifications, for every potential type of FAA program.

4.   Order 8110.4, *Type Certification*

This document defines the FAA procedures followed to issue new or modified airworthiness certifications, identified as TCs. These are inclusive of supplemental, amended, and amended supplemental TCs.

Figures 8 and 9 show the flow diagrams for the type certification process from this order (U.S. Department of Transportation Federal Aviation Administration 2007). This process focuses on obtaining and maintaining the airworthiness certificate. It describes this process as broken into five phases: conceptual design, requirements definition, compliance planning, implementation, and post certification activities. Between these phases, as well as before certification flight tests, the applicant and the FAA hold type certification board meetings (TCBMs). The FAA is not the paying customer for the program, and is concerned only with an executable schedule supportable by the FAA's own resource constraints. Not passing a gate review may greatly delay the schedule until the FAA has resources available again.
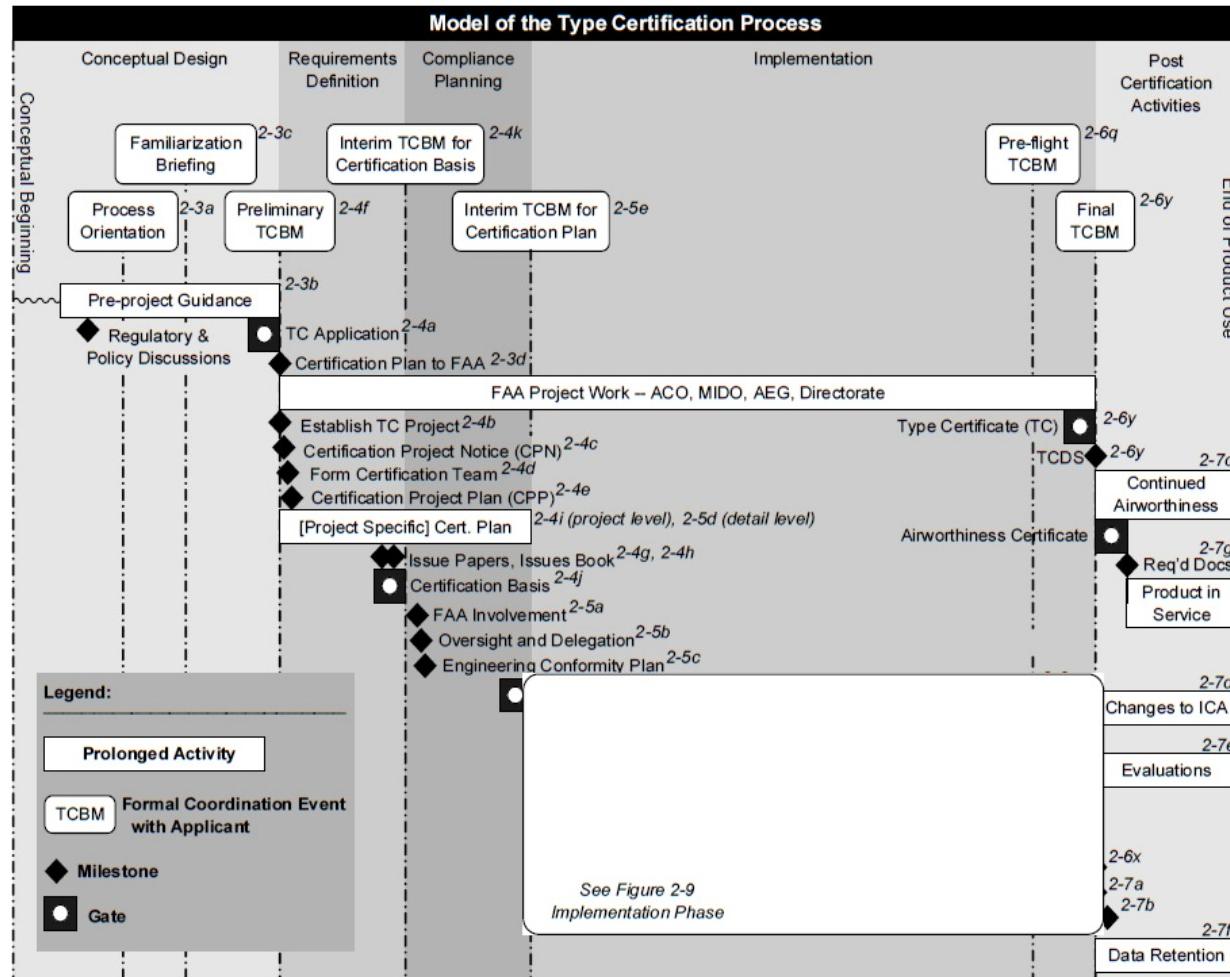
Figure 8.   Typical Type Certification Process. Source: U.S. Department of Transportation Federal Aviation Administration (2007).

Model of the Type Certification Process, Implementation Phase
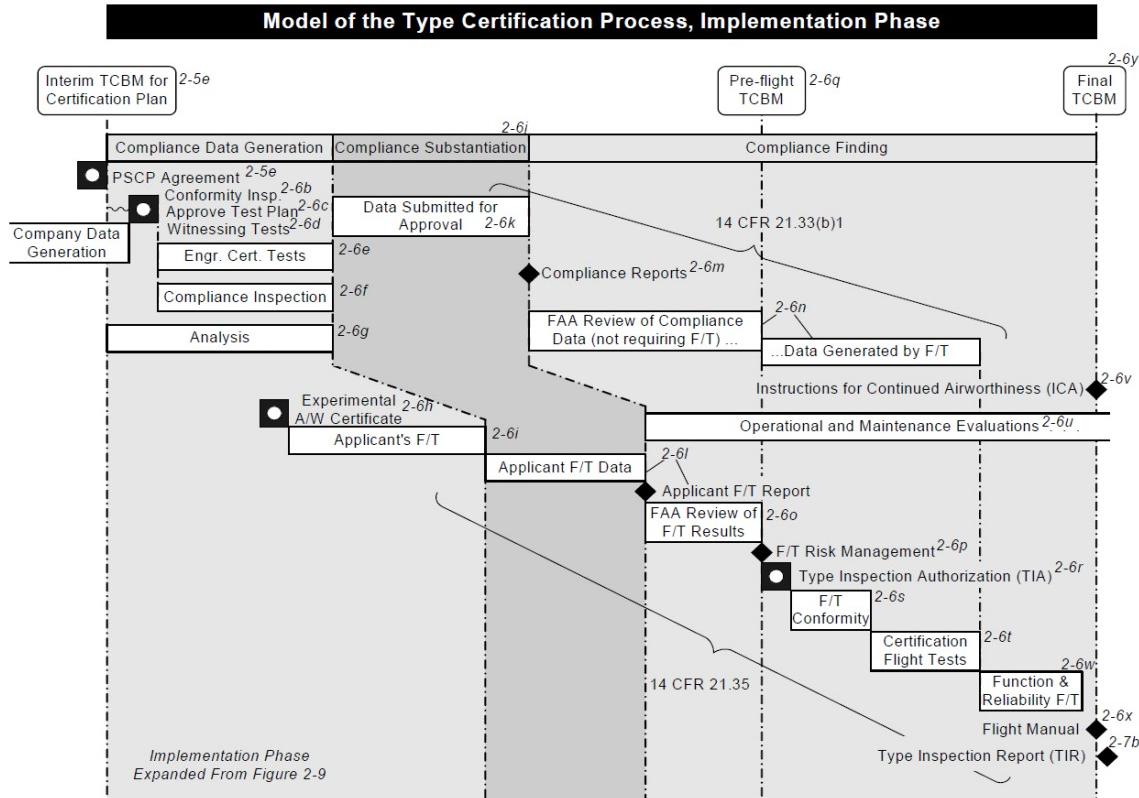
Figure 9.   Typical Type Certification Process, Implementation Phase.
Source: U.S. Department of Transportation Federal Aviation
Administration (2007).

The conceptual design phase is where the applicant is determining the bounds of their program and the scope of a new TC. During this phase, the applicant can ask questions of the FAA on processes in general, but not in specific. The applicant can brief the FAA on their program, giving the FAA time to consider resources and potential levels of oversight engagement. The FAA will not respond in specific until after a formal TC application, accompanied by at least a draft certification plan (CP).

The requirements definition phase is where the FAA officially acknowledges the program, and makes decisions regarding involvement and FAA resource availability, documented in the certification project plan (CPP). The applicant begins drafting the project specific certification plans (PSCPs), with detailed execution planning. Issue papers discuss potential areas of compliance risk and their solutions. The FAA also defines the certification basis in this phase, specifying which 14 CFR criteria are pertinent.

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The compliance-planning phase finalizes execution detailed planning. An engineering conformity plan establishes quality control processes and conformity inspection planning efforts. Completing the PSCPs to a high level of detail, sufficient to determine a high likelihood of successful execution, is required to complete this phase.

The implementation phase is broken down further into three sub-phases: compliance data generation, compliance substantiation, and compliance finding. The complexity of this phase led to its separate breakout in Figure 9. In the compliance data generation sub-phase, the FAA approves test plans prior to execution. The applicant can then begin component level testing, sub-system level testing, and on-aircraft testing, as needed. Performing analyses, building, and performing compliance inspections, potentially witnessed by the FAA, all happen in this phase. When flight test is required, the applicant obtains an experimental airworthiness certificate from the FAA. The applicant must successfully validate compliance before seeking FAA final approval, and is the purpose of this sub-phase. The compliance substantiation sub-phase is where the applicant submits the data to the FAA. The final implementation sub-phase is compliance finding. This is the phase where the FAA reviews data and conducts flight tests. This is the FAA's review of the applicant's results to date, and authorizes inspections and aircraft-level tests for score. The applicant also generates instructions for continued airworthiness, also known as maintenance manuals, and a flight manual.

The FAA reviews the all data, analyses, testing results, and manuals. If the FAA finds compliance, the final TCBM results in the FAA issuing a TC, with a complementary TC data sheet (TCDS).

The post certification activities phase describes airworthiness maintenance activities and process checks on change impacts.

The remainder of this order discusses process points, form details, unique certification topics, and noise certification.

## 5.	Order 8110.101, *Type Certification Procedures for Military Commercial Derivative Aircraft*

This document discusses how the FAA evaluates type certification for MCDA (U.S. Department of Transportation Federal Aviation Administration 2015b). This order is a supplement to Order 8110.4, discussing unique issues in the MCDA context. An agreement between the military and the FAA resulted in the creation of the FAA's Military Certification Office (MCO). The MCO manages MCDA airworthiness projects, functioning as a unique entity capable of understanding military applications held to civil regulations. Since the basic premise of an MCDA is to begin with a commercial aircraft and modify it, the MCO rarely issues new TCs; most MCDA projects are either amended or supplemental type certificates (ATCs or STCs).

A note in this document highlights that the procurement contract defines the relationship between the applicant and the military; the contract does not bind the FAA/ MCO. While the MCO exists to support MCDA, the military does not automatically receive any access to communications between the FAA/MCO and the applicant. The contract must define such.

The procedures followed are still per Order 8110.4 for obtaining airworthiness certification. Military government furnished equipment (GFE) must still comply with civil regulations; missing data is either gathered, or restrictions are imposed. If civil regulations do not address the military equipment function, it is not eligible for an FAA airworthiness certificate, such as weapons or electronic jamming systems. In cases where the FAA cannot test the performance of an item of GFE, such as encryption, a statement from the military is acceptable attesting to the item meeting its intended function. This order also discusses the additional points of process regarding funding, military sponsorship, and potential application of military functions to civil aviation.

The seams between the FAA/MCO and the military must be clear. The FAA provides a list of what deviations are not certified. The military assesses these deviations, in addition to any modifications made by the military after receipt, for airworthiness. This order also touches on the military use of MIL-HDBK-516 for determining airworthiness criteria.

C.   CHAPTER SUMMARY

This chapter first reviews NAVAIR documentation, then FAA documentation. The documents reviewed relate to each entity's requirements development and procedural guidance. A NAVAIR instruction on technical reviews and CDA programs is directly on point for this thesis, but is no longer active. The section then discusses the NAVAIR instructions for SETR process and airworthiness policy. The section ends with descriptions of two documents for airworthiness and performance requirements development, which do not reference each other. The chapter then switches to discussing FAA documentation, describing the structure and hierarchy first. The section briefly describes the regulation defining FAA requirements, then the order defining FAA airworthiness. A description of the FAA certification process order follows, with an additional description of the order created to support military CDA in the FAA. The section ends with a short overview of the unique reviews conducted at the component level. The analysis in the next chapter uses the data and information provided here.

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III. ANALYSIS OF DATA

This chapter presents the analyses of the data discussed in the previous chapter. A comparison of airworthiness definitions frames the difference in perspectives, followed by a comparison of airworthiness tenets that finds common ground. Identification of commonalities between TRR, FRR, FCA, and SVR entrance criteria ensures consistency in the final analyses. The major analysis effort compares the SETR timeline to the TC process. This begins with an overall simplified view, and then focuses on each phase separately to identify where FAA elements align with SETR events. The final deliverables are diagrams mapping identified FAA elements to specific SETR entrance criteria for TRR, FRR, FCA, and SVR.

NAVAIR and the FAA have fundamentally different approaches for documenting policies and procedures, as well as documentation formatting styles. Even internally within NAVAIR and the FAA, different documents' structures may differ greatly given different purposes, authors, and historical development. Therefore, different methods are appropriate for each document comparison. The empirical analysis comparison types are written, tabular, timeline alignment, and mapping diagrams. The differing documents' structures and intent of the comparison drive the format selected by this author.

A. AIRWORTHINESS COMPARISONS

This section will discuss the similarities and differences of airworthiness approaches between NAVAIR and the FAA. The analyses justify how FAA airworthiness assessment scope encompasses NAVAIR's in the majority, and why NAVAIR-4.0P allows use of FAA airworthiness products.

1. Airworthiness Definitions

Repeating the definitions from NAVAIR and the FAA allow for ready comparison:

Assessment of the airworthiness of an air system configuration determines its ability to safely attain, sustain and terminate flight ("complete" in case of UAS) per approved usage limits. … Assessment of Safety of Flight (SOF) determines the property of an air system configuration to safely

attain, sustain, and terminate or complete flight (to include in-flight or post-flight aircrew survivability), within prescribed and accepted limits for injury or death to personnel, damage to equipment, property, and/or environment. The intent of assessing SOF is to show that the level of system safety risk (hazards resulting in death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment) have been appropriately identified by the Technical Area Experts (TAE), accepted by the appropriate authority, and concurred with by the fleet or test user for high and serious risks… (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016, 1-2, 1-3)

The aircraft must conform to its type design. For the purpose of airworthiness, conformity to the type design is considered attained when the aircraft configuration and the engine, propeller, and articles installed are consistent with the drawings, specifications, and other data that are part of the type certificate (TC). This includes any supplemental type certificate (STC) and repairs and alterations incorporated into the aircraft.

The aircraft must be in a condition for safe operation. This refers to the condition of the aircraft relative to wear and deterioration, for example, skin corrosion, window delamination/crazing, fluid leaks, and tire wear. (U.S. Department of Transportation Federal Aviation Administration 2015a, 2-1)

The two definitions at first seem fundamentally different. NAVAIR focuses first on the integrity of the aircraft itself within allowable damage limits to other entities and then on determination of safety risk level and acceptance (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016). The FAA first discusses verifying the aircraft's conformance to its authorized design and then discusses evaluating the condition of the aircraft for safe operation (U.S. Department of Transportation Federal Aviation Administration 2015a).

NAVAIR pointedly allows for varying levels of safety risk. The FAA's requirement for design conformity in itself allows for no safety risk acceptance; the design must comply with regulations, the minimum requirements for safety. It follows then, the FAA evaluates requirements NAVAIR would consider performance only. This difference explains the relative size of the airworthiness requirement bubbles in Figure 10. The NAVAIR portion protruding outside of the FAA's is for areas the FAA cannot certify due to unique military applications.

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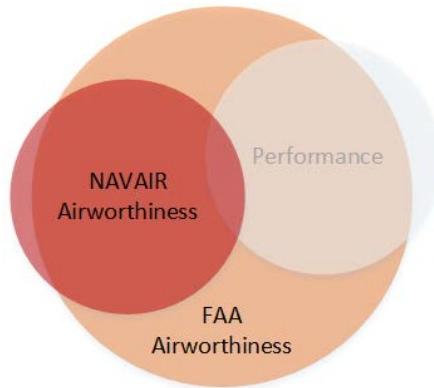
Figure 10.   NAVAIR vs. FAA Airworthiness Venn Diagram

Unlike the FAA, the NAVAIR airworthiness definition does not call for design conformity, or safe maintenance. NAVAIR-4.0P addresses these topics separately in the consideration of everything impactful to airworthiness (NAVAIR 2016a). The NAVAIR definition itself focuses more narrowly than the FAA's.

At first glance, the definitions seem very different, but do have a great deal in common when framed by their full documentation. Both airworthiness perspectives address design conformity and maintaining in a safe status. Both address safety risk, whether explicitly or intrinsically; they differ most significantly in their tolerance of safety risk.

2.   Airworthiness Tenets

NAVAIR lists and discusses six tenets of airworthiness (NAVAIR 2016a). While the FAA does not explicitly identify individual tenets, Table 1 identifies equivalents (U.S. Department of Transportation Federal Aviation Administration 2007).

Table 1.   Airworthiness Tenets Comparison

NAVAIR 13034.1	FAA
1. Continuing Airworthiness	
1a. Configuration Management	Conformity Inspection (U.S. Department of Transportation Federal Aviation Administration 2015a) (U.S. Department of Transportation Federal Aviation Administration 2007)
1b. Maintenance	Instructions for Continued Airworthiness (U.S. Department of Transportation Federal Aviation Administration 2015a) (U.S. Department of Transportation Federal Aviation Administration 2007)
1c. Material Management	Manufacturing Production Approval (U.S. Department of Transportation Federal Aviation Administration 2007)
2. Training	Training (U.S. Department of Transportation Federal Aviation Administration 2015a) (U.S. Department of Transportation Federal Aviation Administration 2007)
3. Safety	14 CFR
4. Flight Tests	Flight Test (U.S. Department of Transportation Federal Aviation Administration 2015a) (U.S. Department of Transportation Federal Aviation Administration 2007)
5. SETR	TC Process (U.S. Department of Transportation Federal Aviation Administration 2007)
6. Airworthiness Products	TC/STC (U.S. Department of Transportation Federal Aviation Administration 2007)

While using different terminologies, both entities do consider the same tenets as fundamental to establishing and maintaining airworthiness. Each tenet has its own suite of processes for management and detailed implementation, but both NAVAIR and the FAA identify these key areas in their airworthiness documentation. This similarity enables the airworthiness leveraging by NAVAIR-4.0P.

B. TRR, FRR, FCA, SVR SETR ENTRANCE CRITERIA COMPARISONS

This section analyses NAVAIR SETR event entrance criteria for commonality, enabling consistent mapping for the later NAVAIR SETR timeline to FAA TC process comparison analysis.

The entrance criteria for TRR, FRR, FCA, and SVR (NAVAIR 2015b) have a great deal in common. While TRR and FRR assess test readiness and flight readiness, respectively, FCA and SVR are often performed together to assess requirement compliance of the design. Figure 11 maps a comparison of these entrance criteria; a solid green line indicates duplicated entrance criteria, a double green line indicates related entrance criteria, and a lack of any green lines indicates a unique entrance criteria. See the Appendix for an excerpted listing of the full entrance criteria descriptions for these four reviews.
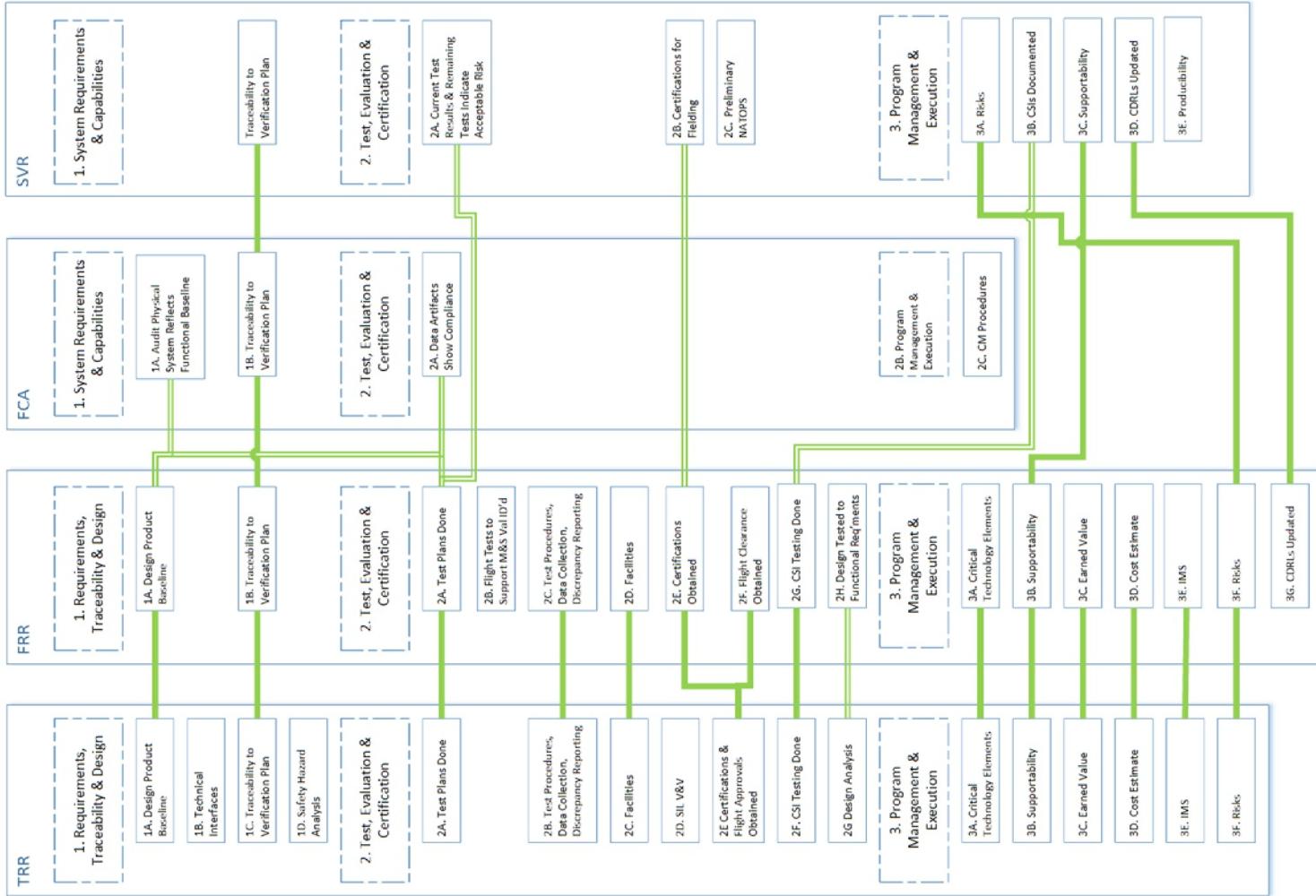
Figure 11.   TRR, FRR, FCA, and SVR Entrance Criteria Mapping

The overlap between the first two events is understandably high; a TRR may or may not need flight to gather data, while an FRR focuses specifically on flight readiness. The primary overlap across all four events is the entrance criterion assessing requirements traceability to verification. A key secondary entrance criterion assesses appropriate certifications for each of these events.

By comparing these four events against each other and identifying commonalities, Figure 11 provides a tool to ensure the FAA element comparison analysis performed later in this chapter is consistent in mapping to common and related entrance criteria.

C.   SETR TO TYPE CERTIFICATION PROCESS COMPARISON

This section presents the direct mapping analyses. First, this section compares a simplistic overall SETR timeline to the overall TC process. Separate comparison of major phases follow, which in turn enables mapping of FAA process to NAVAIR SETR. The final products, by SETR event, map FAA elements to specific entrance criteria.

1.   SETR Timeline to FAA Type Certificate Process Comparison

Not all phases of SETR shown in Figure 6 are necessary for this thesis. By the nature of executing a CDA program, the program has already reached many critical decisions; efforts prior to Milestones A and B authorize the CDA path. Note SETR events occur independent of what milestone or phase a program begins; the alignment of Figure 6 is notional and each program adjusts as needed (NAVAIR 2015b). The FAA TC process focuses only on obtaining and maintaining the airworthiness certificate, while NAVAIR's SETR process supports the entire acquisition and life cycle of a program. Figure 12 presents a comparison of a simplified NAVAIR SETR timeline based on Figure 6 to the FAA's TC process of Figures 8 and 9.
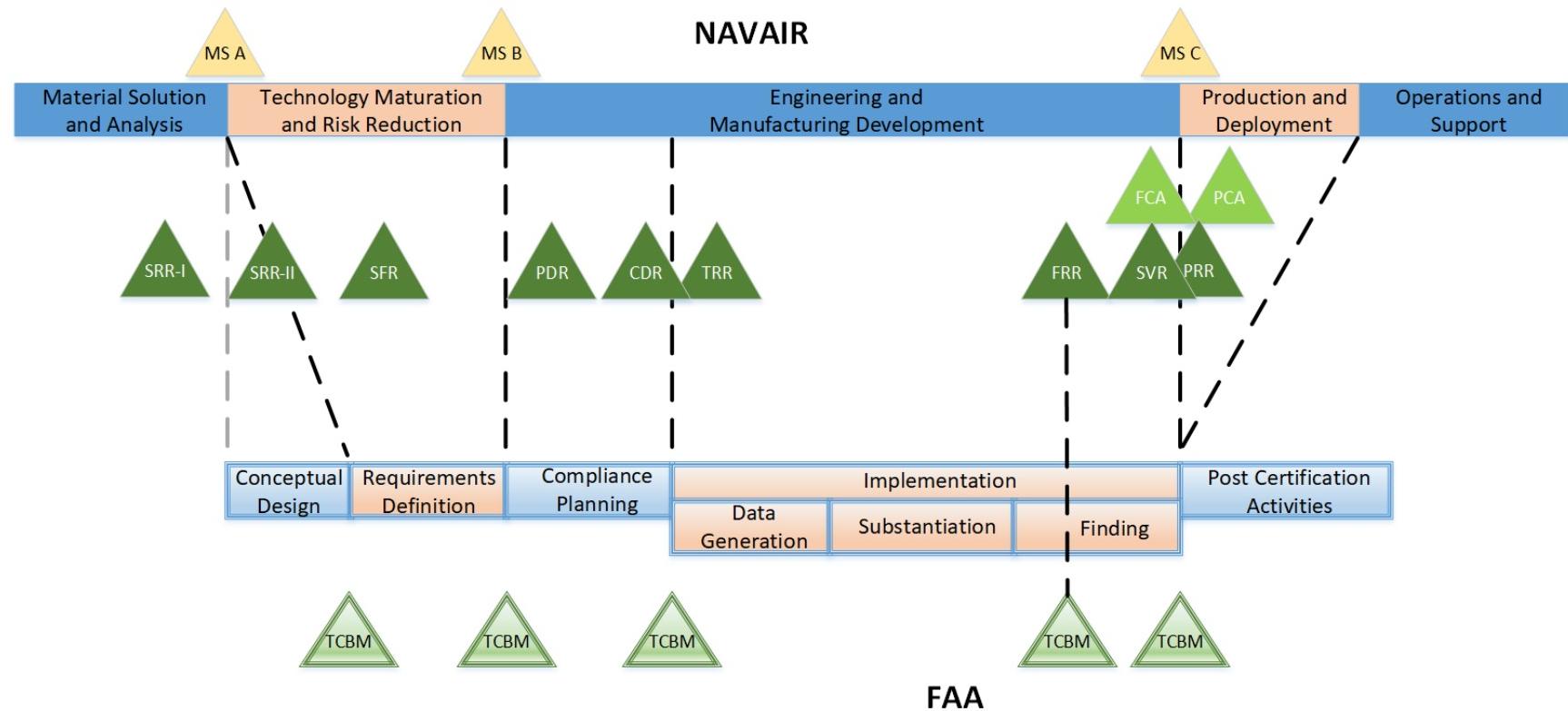
Figure 12.   NAVAIR SETR to FAA TC Process Comparison

The FAA's conceptual design phase correlates to NAVAIR's material solution and analysis phase. This initial phase scopes the program, investigates feasibility, plans notional execution and defines overall program requirements. Acquisition execution dictates a shift in the alignment of these two phases; the FAA TC process would not begin until after selection of a contractor at Milestone A. The FAA's requirements definition phase correlates to NAVAIR's technology maturation and risk reduction phase. This in-depth phase investigates execution feasibility in detail and finalizes detailed requirements. NAVAIR's engineering and manufacturing development (EMD) phase encompasses two major FAA phases, compliance planning and implementation. The FAA's compliance-planning phase fully develops the design; in the NAVAIR timeline, PDR and CDR assess the design to full maturity. The remainder of NAVAIR's EMD phase correlates to the FAA's implementation phase. The implementation phase is broken down further into three sub-phases: data generation, substantiation and finding. Build, analysis, and testing occur in this phase. At the end of the EMD and implementation phases, the two timelines converge again, with the final assessment determining compliance. NAVAIR then moves on to managing production execution in the production and deployment phase. The FAA TC process focuses only on airworthiness compliance, so the production phase does not have a counterpart; this is an aspect of NAVAIR being the procuring customer, while the FAA is not. Finally, the FAA's post certification activities phase addresses airworthiness maintenance aspects. NAVAIR's operations and support phase also addresses these, in addition to many other considerations relevant to being the user.

a.   ***Conceptual Design, Requirements Definition Compared to Material Solution and Analysis, Technology Maturation and Risk Reduction Phases***

Figure 13 focuses on the FAA's conceptual design and requirements definition phases, presenting key elements for comparison to the NAVAIR phases. The products of the conceptual design phase and true kick-off for an FAA certification project are the initial CP and the TC application. These products define the scope of the program, the notional execution schedule, and formal request by the applicant to the FAA to initiate the TC process. This phase has the same purpose as NAVAIR's material solution and design

analysis phase where program requirements are scoped and the Milestone A decision authorizes a program to move forward. A military CDA program would not begin the FAA TC process until after selection of a contractor, so the FAA conceptual design phase would shift to the right as shown in Figure 13. The applicant submits the CP and TC application after showing understanding of the government's requirements in SRR-II. The preliminary TCBM between the applicant and the FAA at the end of the conceptual design phase begins the FAA's official establishment of the TC effort.
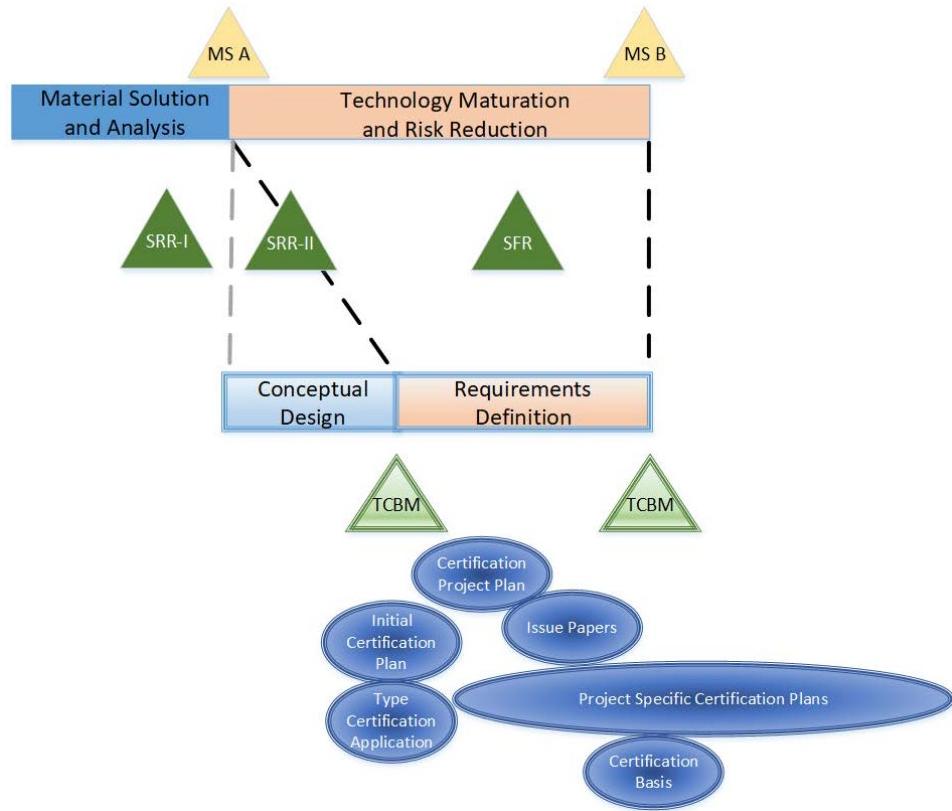
Figure 13.   FAA Key Documents for First and Second Phases

The products of the requirements definition phase are the initial CPP, issue papers, initializing PSCPs and the certification basis. The CPP defines execution details and resource allocation within the FAA; issue papers describe areas of technical concern; the initial PSCPs begin to frame compliance planning details; and the final product of this phase is the certification basis, defining which specific regulations must be satisfied. This

phase correlates to NAVAIR's technology maturation and risk reduction phase where investigation determines the feasibility of execution details and the requirements are refined to the detailed level. As draft PSCPs begin to flesh out the design, an allocated baseline emerges, aligning with the SFR. The definition of the certification basis moves the program forward into the next phase to complete design work, comparable to a Milestone B decision authorizing a program to move into EMD. The FAA and applicant hold an interim TCBM for certification basis at the end of the requirements definition phase.

b.   *Compliance Planning Compared to Engineering and Manufacturing Development Phase*

Figure 14 focuses on the FAA's compliance-planning phase, presenting key elements for comparison to the beginning of the NAVAIR EMD phase. The products of the compliance-planning phase are the development of a conformity plan, the completion of the PSCPs, and a finalized certification plan. The PSCPs must be completed and approved by the FAA in order to move into the implementation phase following. These products finalize design and compliance planning details. This phase has the same purpose as the first portion of NAVAIR's EMD phase, fully maturing and assessing design through PDR and CDR. The FAA and applicant hold an interim TCBM for certification plan at the end of the compliance-planning phase.
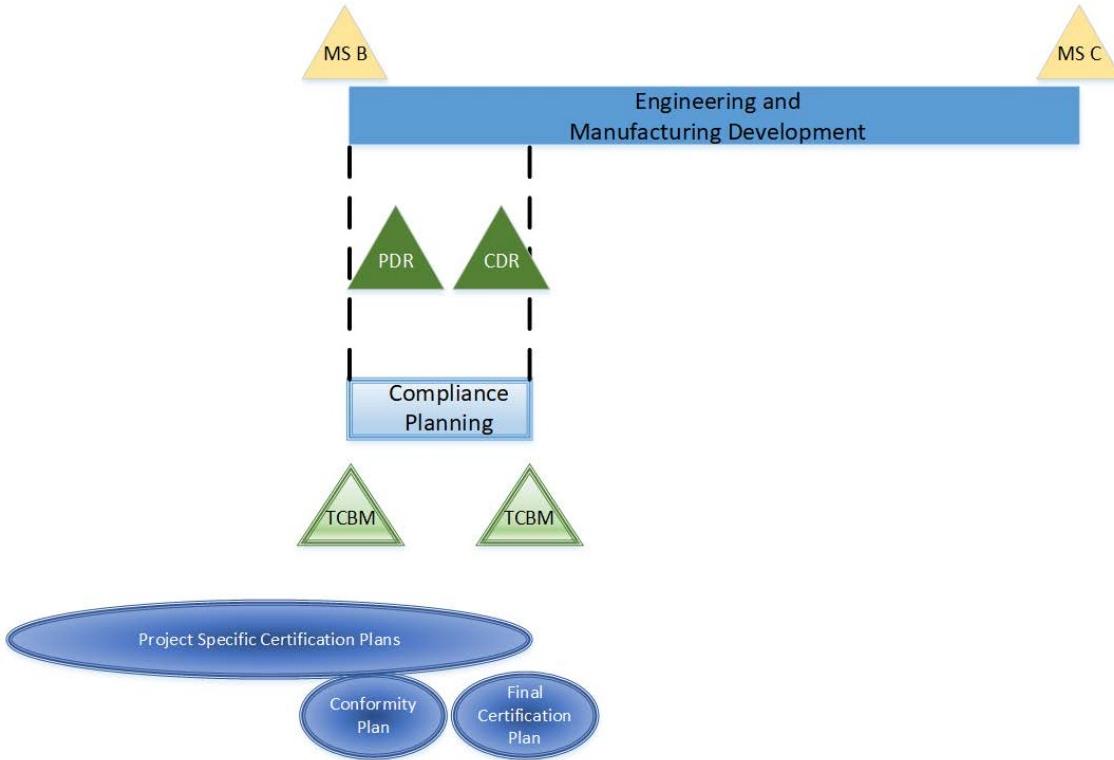
Figure 14.   FAA Key Documents for Compliance Planning Phase

c.   *Implementation Compared to Engineering and Manufacturing Development Phase*

Figure 15 focuses on the FAA's implementation phase, presenting key elements in comparison to the remainder of the NAVAIR EMD phase. This is the execution phase, where analysis, building, and testing occur. The implementation phase is further broken down into three sub-phases: data generation, substantiation, and finding.
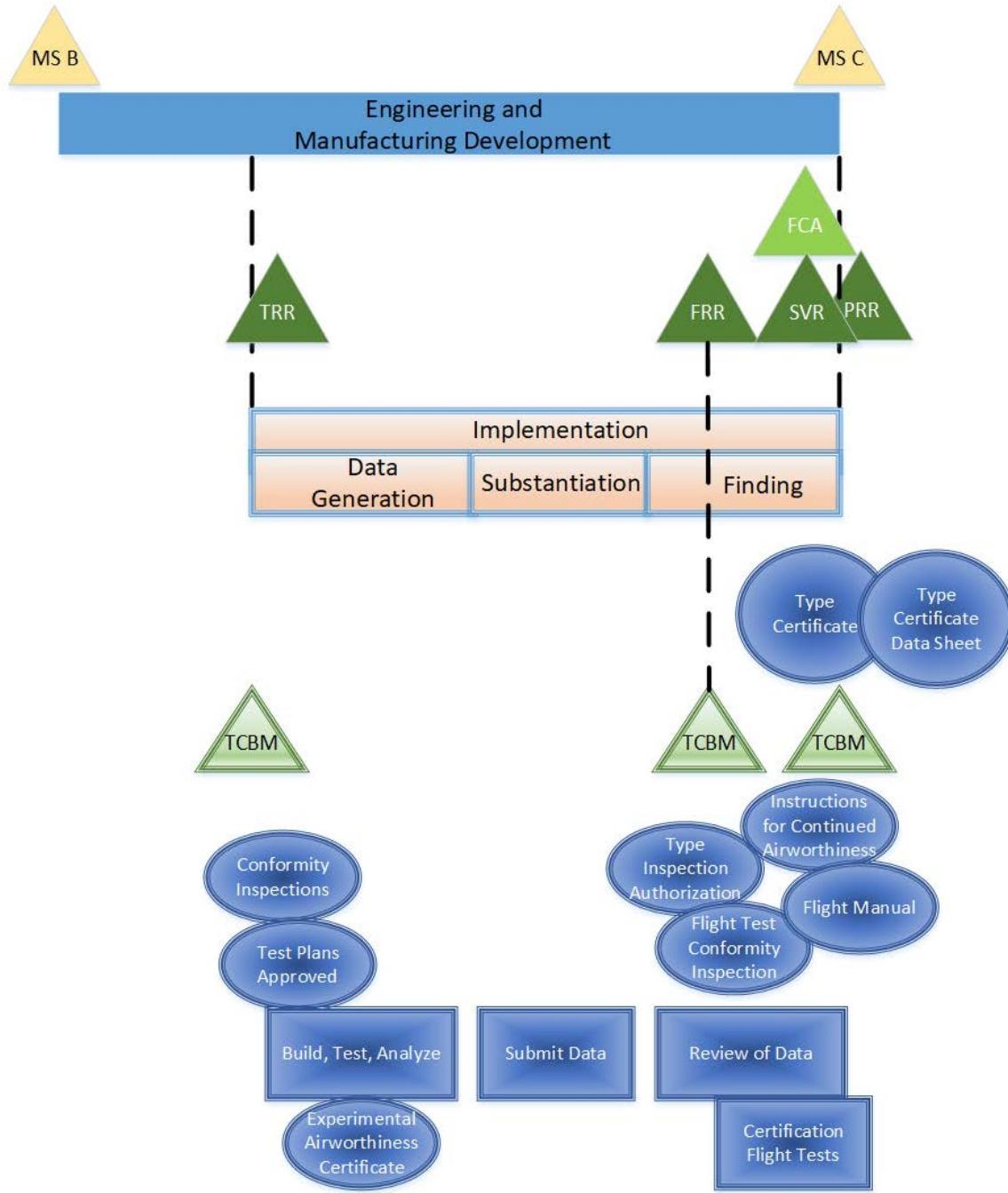
Figure 15.　FAA Key Documents and Processes for Implementation Phase

The applicant performs a great deal of effort in the data generation phase, where analysis, build, and testing occur to the applicant's satisfaction. The FAA oversees portions of this phase, witnessing conformity inspections, approving all test plans, and providing an

experimental airworthiness certificate to authorize the applicant's flight tests. This phase correlates to NAVAIR's TRR, where assessment of the design evaluates its readiness for component or sub-system level testing as appropriate. TRRs may occur several times, as needed to support design development testing. When the applicant believes all compliance data is sufficient, the applicant submits the data to the FAA in the substantiation sub-phase.

The finding sub-phase is critical, as this is where the FAA will evaluate data and perform their own tests for score. The products of the finding sub-phase are the TIA, the flight-test-conformity inspection, instructions for continued airworthiness, and the flight manual. The TIA formally accepts contractor submitted results and authorizes the FAA to conduct the airworthiness conformity inspection and flight tests to follow. Concurrently, the applicant develops and submits the instructions for continued airworthiness (ICA) providing maintenance procedures to maintain airworthiness, and the flight manual to provide flight and operational procedures. The pre-flight TCBM correlates to NAVAIR's FRR, assessing readiness of the program to move into flight test for score.

The culmination of the implementation phase happens at the final TCBM. The FAA will review all data at this TCBM, and if compliant to the regulations, the FAA issues the TC and accompanying TCDS. Issuance of these documents is the goal of the TC process. This evaluation and release of the goal product correlate to NAVAIR's FCA and SVR, assessing final compliance of the program as a whole, but remember NAVAIR assesses more than airworthiness as the acquiring customer. Note NAVAIR's PRR is on the heels of the FCA and SVR, supporting the Milestone C decision to go into the production phase, discussed next.

d. Post Certification Activities Compared to Production and Deployment, Operations and Support Phases

Figure 16 focuses on the FAA's post certification phase, compared to the remainder of the NAVAIR phases: production and deployment, and operations and support. The immediate product is the type inspection report (TIR). The TIR formally documents the full details of compliance results after the issuance of the TC in the previous phase. This

document also reports on conformity findings, helpful to NAVAIR's Physical Configuration Audit (PCA).
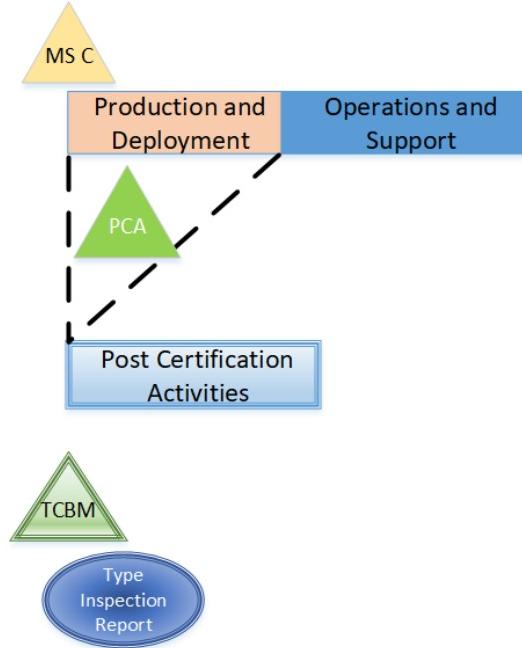

Figure 16.   FAA Key Documents for Post Certification Phase

NAVAIR is the procuring activity as well as supporting user activity; production execution and deployment to the user do not have counterparts in the FAA TC process, whose purpose is solely airworthiness certification. The FAA's post certification activities phase addresses considerations and policies for maintaining airworthiness. NAVAIR's operations and support phase addresses these same considerations and a great deal more.

2.   TRR, FRR, FCA, SVR SETR Entrance Criteria Mapping to FAA Elements

The previous section of this chapter compares the entire NAVAIR SETR timeline to the FAA TC process. This section narrows the scope of the final analysis to the TRR, FRR, FCA, and SVR SETR events. This is the portion of the NAVAIR SETR timeline focusing on verification preparation and verification completion, and is the scoped focus of this thesis. Mapping diagrams relate FAA elements to specific SETR entrance criteria

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for these four events. NAVAIR, as the acquirer, military airworthiness authority, maintenance and user supporting activity, is examining many aspects beyond airworthiness in SETR. These mappings do not propose equivalency to entrance criteria, but bring awareness and acknowledgement of the FAA elements relevant to the CDA portions of those specific criteria. Acceptance of these FAA elements as satisfying the CDA portions of those specific criteria is the true benefit to executing SETR on a CDA program.

SETR groups entrance criteria into three areas: requirements, traceability and design; test, evaluation and certification; and program management and execution (NAVAIR 2015b). These mappings utilize Figure 11 to crosscheck consistent mapping across the four SETRs with common entrance criteria. With the role of NAVAIR as acquirer and user differing from the FAA's sole focus as the airworthiness approval authority, almost no FAA elements map to the program management and execution group. There is one exception in FCA. To save graphic space, the mapping diagrams do not list the entrance criteria for this group in the other events. The Appendix lists all entrance criteria in full for these four events.

a. TRR Entrance Criteria Mapping

Figure 17 maps TRR entrance criteria to FAA elements from the data generation sub-phase of the implementation phase. The FAA and the applicant hold an interim TCBM for certification plan at the beginning of the implementation phase, to finalize certification planning and assess readiness for moving into implementation. Reviewing actions and results from this TCBM may also benefit TRR entrance criteria. Examining a specific SETR entrance criterion on the left, the presence of a solid blue line indicates there is an FAA element to consider. In many cases, a single FAA element maps to several SETR entrance criteria. Out of the eleven entrance criteria reviewed, eight have FAA element counterparts.
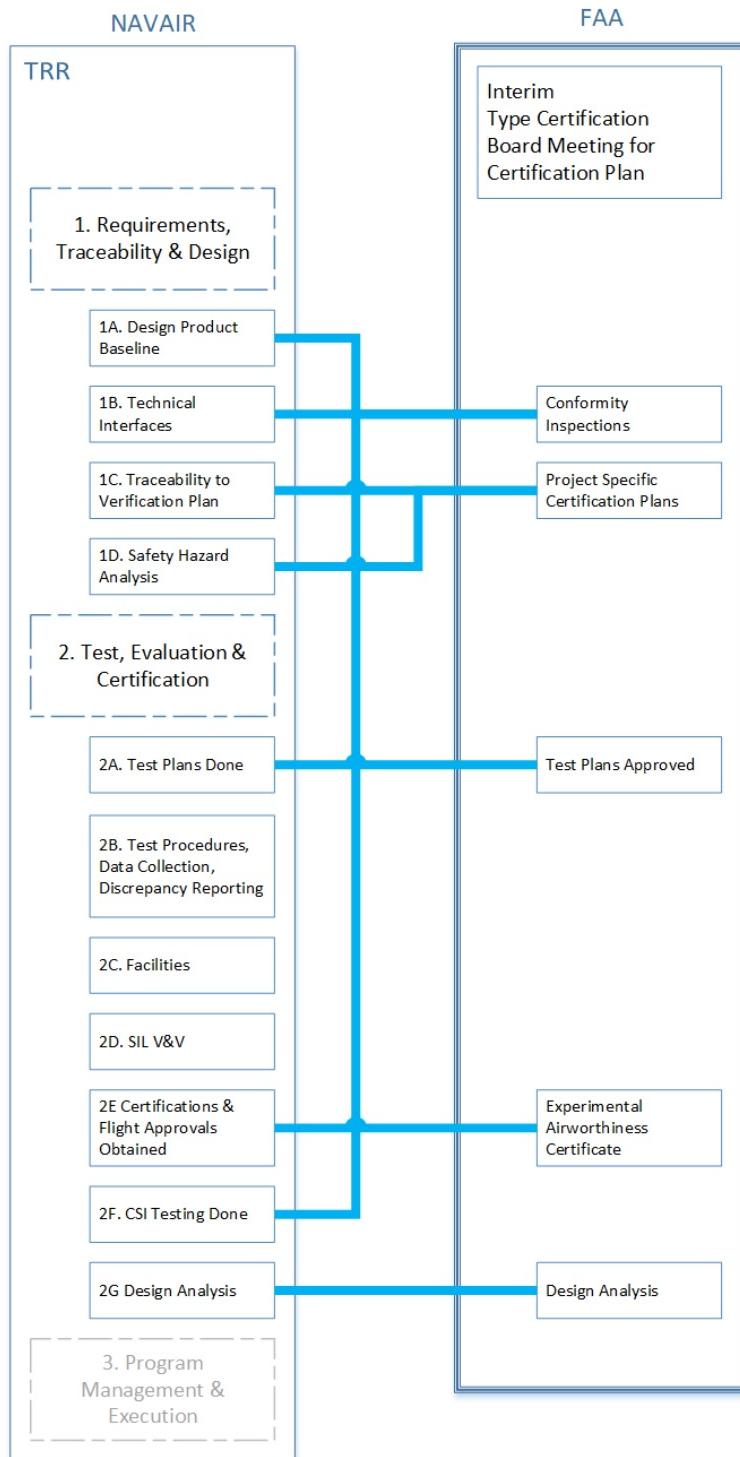
Figure 17.   TRR Entrance Criteria Mapping to FAA Elements

In the requirements, traceability and design group, the entrance criteria for design product baseline (1A), technical interfaces (1B), and critical safety item (CSI) testing done (2F) from the second group connect to conformity inspections. A conformity inspection verifies a product's build matches its design, and is required for key components and subsystems. Any conformity inspections conducted prior to the TRR assessment verify those specific components' product baseline and interfaces. As previously discussed, the FAA accepts safety risk differently than NAVAIR, but any components requiring conformity inspections will categorize as CSIs. The entrance criteria for traceability to verification plan (1C) and safety hazard analysis (1D) connect to PSCPs. These plans define the details of what regulations are applicable, how the design shows satisfaction to those regulations, and the verification methodology to show compliance. The PSCPs provide traceability from the parent regulations, or requirements, to the design execution and verification methodology. The FAA's focus on safety and impact to airworthiness requires execution of safety hazard analyses to determine what level of testing is required; PSCP development builds a safety hazard analysis into the process.

In the test, evaluation and certification group, the entrance criterion for test plans done (2A) connects to test plans approved. The FAA requires test plan approval prior to execution by the applicant, even in the data generation phase where the FAA may only witness portions of testing and the majority will not be for score. The entrance criteria for certifications and flight approvals obtained (2E) map to experimental airworthiness certificate. When the applicant needs to conduct system-level flight tests, the FAA issues an experimental airworthiness certificate; NAVAIR issues an IFC. The FAA experimental airworthiness certificate very tightly defines and limits allowable flights. The entrance criterion for CSI testing done (2F) connects to conformity inspections, already discussed. The entrance criterion for design analysis (2G) connects to design analysis. The FAA TC process calls for design analysis in the same manner as NAVAIR. Assessment of design analysis either verifies the design or supports its readiness to move into testing.

The remaining entrance criteria for test procedures, data collection, discrepancy reporting (2B), facilities (2C), and simulation lab (SIL) verification and validation (V&V) (2D) do not benefit from FAA element mapping. These criteria are also necessary to

program execution by the applicant, but the TC process does not explicitly identify them. These test execution details are still pertinent to testing conducted by NAVAIR.

b. *FRR Entrance Criteria Mapping*

Figure 18 maps FRR entrance criteria to FAA elements from the finding sub-phase of the implementation phase. Comparing FRR to TRR, many entrance criteria are the same. FRR focuses narrowly on readiness to support flight test, while TRR assesses readiness to test in general. As a result, many mapping correlations are the same. The FAA and applicant hold a pre-flight TCBM prior to authorizing flight tests for score. Reviewing actions and results from this TCBM may also benefit FRR entrance criteria. Out of the ten entrance criteria reviewed, seven have FAA element counterparts
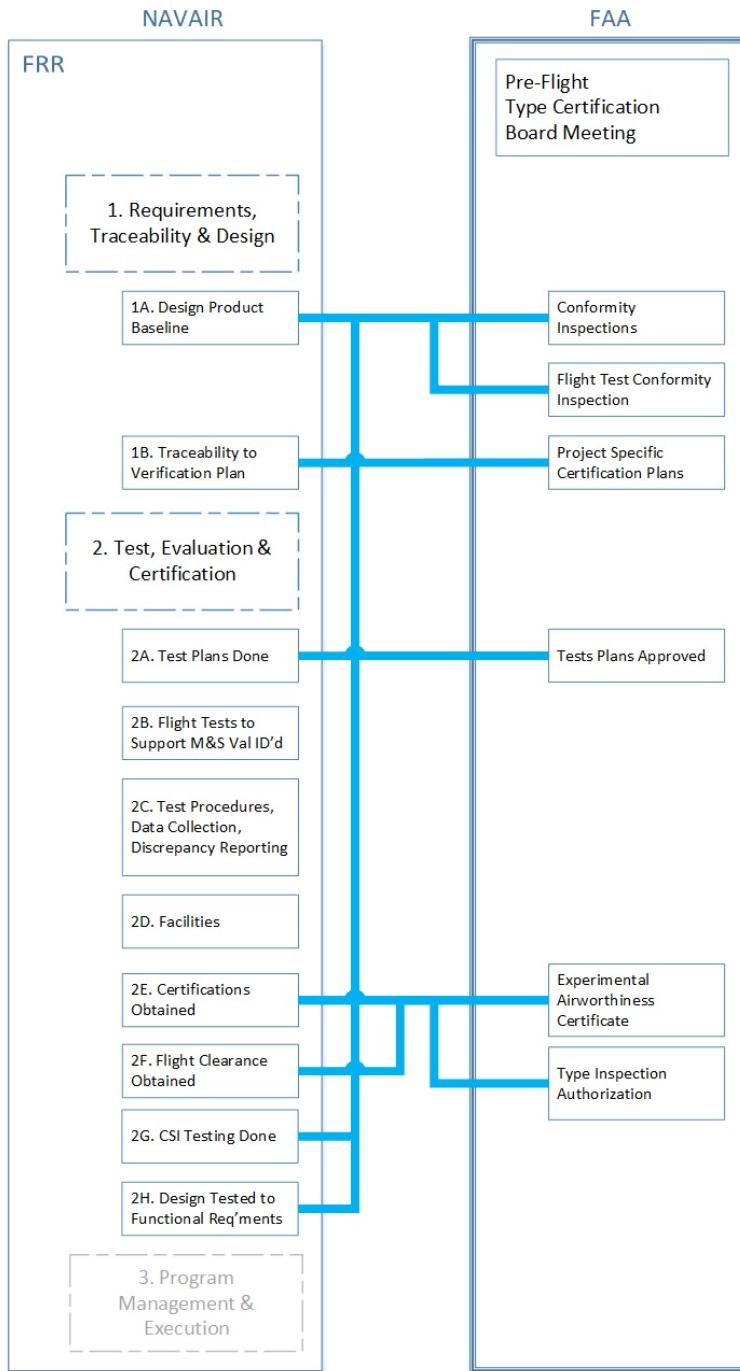
Figure 18.   FRR Entrance Criteria Mapping to FAA Elements

In the requirements, traceability and design group, the entrance criteria for design product baseline (1A), CSI testing done (2G), and design tested to functional requirements

(2H) connect to conformity inspections. The same rationale from the TRR mapping applies here. The entrance criterion for design product baseline (1A) also connects to the flight-test-conformity inspection. This conformity inspection verifies the aircraft as a whole is ready to move into flight test for score by the FAA.

In the test, evaluation and certification group, the entrance criterion for test plans done (2A) connects to test plans approved. The same rationale from the TRR mapping applies here. The entrance criteria for certifications obtained (2E) and flight clearance obtained (2F) map to experimental airworthiness certificate and TIA. FRR splits the TRR entrance criterion for "certifications and flight approvals obtained" into two separate criteria. The rationale from the TRR mapping for the experimental airworthiness certificate applies here, mapping the experimental airworthiness certificate to both 2E and 2F. The addition here in FRR is also mapping 2E and 2F to the TIA. The FAA issues a TIA to authorize the flight-test-conformity inspection and flight tests for score. The entrance criterion for CSI testing done (2G) connects to conformity inspections, already discussed. The same rationale from the TRR mapping applies here.

The entrance criterion for flight tests to support modeling and simulation (M&S) validation identified (2B) is not explicitly addressed in the FAA TC process. Execution details and related processes may address, but further investigation is required. The remaining entrance criteria for test procedures, data collection, discrepancy reporting (2C), and facilities (2D) do not benefit from FAA element mapping. These test execution details are still pertinent to testing conducted by NAVAIR.

c.   FCA Entrance Criteria Mapping

Figure 19 maps FCA entrance criteria to FAA elements from the finding sub-phase of the implementation phase. FCA is an audit rather than a SETR event, explaining its reduced entrance criteria. The FAA and applicant hold a final TCBM at the end of the implementation phase. Reviewing actions and results from this TCBM may also benefit FCA entrance criteria. Out of the five entrance criteria reviewed, four have FAA element counterparts.

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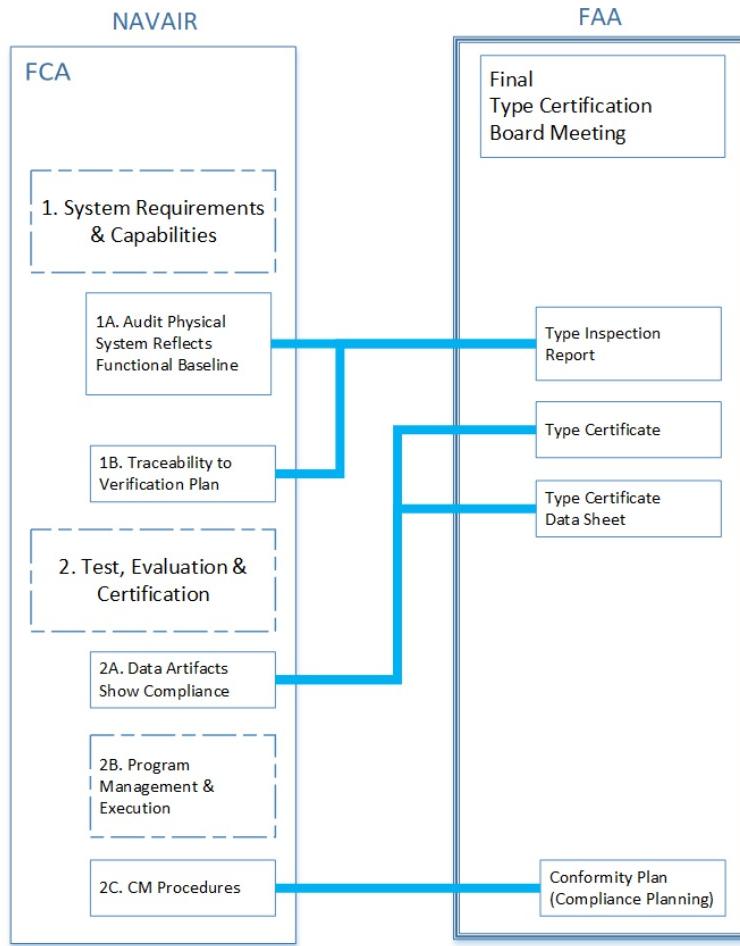
Figure 19.   FCA Entrance Criteria Mapping to FAA Elements

In the system requirements and capabilities group, the entrance criteria for audit physical system reflects functional baseline (1A) and traceability to verification plan (1B) connect to the TIR. Generation of this report actually occurs in the post-certification activities phase, documenting all the results and details justifying the release of the TC. If a draft is available, or execution timing aligns with the FCA audit, the TIR supports these criteria. As shown in Figure 19, the traceability to verification plan (1B) entrance criterion is also in TRR and FRR. The mapping is different here as the artifacts discussed shift from pre-verification to post-verification.

In the test, evaluation and certification group, the entrance criterion for data artifacts show compliance (2A) connects to the TC and TCDS. These products are the FAA

airworthiness certificate and issuance does not occur without full compliance proven and accepted.

In the program management and execution sub-group, the entrance criterion for configuration management procedures (2C) connects to the conformity plan. Generation of this plan occurs earlier in the compliance-planning phase, but supports this entrance criterion by documenting the applicant's configuration management processes in addition to conformity planning execution.

d. *SVR Entrance Criteria Mapping*

Figure 20 maps SVR entrance criteria to FAA elements from the finding sub-phase of the implementation phase. SVR and FCA often occur in conjunction. The FAA and applicant hold a final TCBM at the end of the implementation phase. Reviewing actions and results from this TCBM may also benefit SVR entrance criteria. Out of the four entrance criteria reviewed, three have FAA element counterparts.
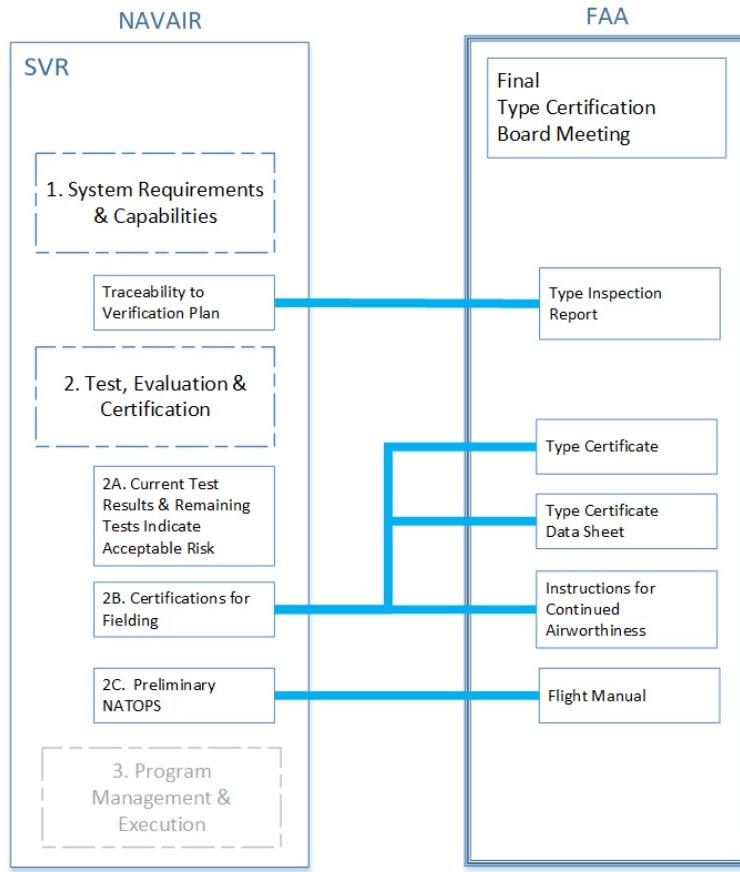
Figure 20.   SVR Entrance Criteria Mapping to FAA Elements

In the system requirements and capabilities group, the entrance criterion traceability to verification plan connects to the TIR. As discussed in the FCA mapping, generation of this report occurs in the post-certification activities phase. If a draft is available, or execution timing aligns with SVR, the TIR supports this criterion.

In the test, evaluation and certification group, the entrance criterion for certifications for fielding (2B) connects to the TC, TCDS, and instructions for continued airworthiness. These products are the FAA airworthiness certificate and accompanying approved maintenance manuals. The aircraft must have these for flight and operations. The entrance criterion for preliminary NATOPS, also known as the PFC, (2C) connects to the flight manual. This is also FAA approved and required for release of the TC and TCDS.

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The remaining entrance criterion for current test results and remaining tests indicate acceptable risk (2A) does not have an FAA element counterpart. The FAA makes no allowance for uncompleted testing and acceptance of risk; everything must be complete and compliant to gain release of a TC.

D. CHAPTER SUMMARY

The analyses presented in this chapter started with a comparison of airworthiness definitions and airworthiness tenets, identifying similarities and differences. This justifies the NAVAIR approach to accept FAA airworthiness certifications, and the assessment NAVAIR has a tighter airworthiness scope due to increased acceptance of safety risk. The chapter then provided an internal comparison of TRR, FRR, FCA, and SVR entrance criteria used in the final analysis as a crosscheck. The largest analysis effort compared the NAVAIR SETR timeline to the FAA TC process, justifying the proposed alignment of the two. Examining each phase of the timeline comparison, allows more detailed analysis. The final analysis used the timeline comparisons to map FAA elements to specific SETR event entrance criteria. Four mapping diagrams, for TRR, FRR, FCA, and SVR, are the product of this chapter.

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IV. CASE STUDY

This chapter discusses a case study, the Presidential Helicopter Replacement Program, providing a background, presenting pertinent challenges, lessons learned, applying the analyses of this thesis, and assessing the benefits of the analyses.

A. PRESIDENTIAL HELICOPTER REPLACEMENT PROGRAM

A high-level background of the VH-92A program provides information justifying its application as a case study for this thesis. Discussion of some challenges and lessons learned during the beginning of this program's execution give a real-world application of several key points in thesis, and lead into the following analysis discussion.

1. Background

Today, the United States Marine Corps operates two helicopter models to fly the President of the United States of America (NAVAIR 2016b). The VH-3D and the VH-60N, beginning military service in the 1970s and 1980s, respectively, are both classic military acquisition and military certified helicopters. As these aircraft age, a replacement helicopter is needed. The original intended replacement, the VH-71, terminated due to cost overgrowth (Gertler 2009). The need remained, and a new approach began. In 2014, a contract was awarded to Sikorsky Aircraft Corporation to integrate defined government mission systems into the commercially available S-92A aircraft; the final integrated aircraft is designated the VH-92A (NAVAIR 2016b). A key point of this acquisition strategy is maintaining the existing airworthiness certification. The original airworthiness certification authority, being the FAA for the S-92A, is to provide the airworthiness certification for the VH-92A as well, to the maximum extent possible. This is a deliberate decision to modify an already existing, airworthiness-certified aircraft and to utilize the same airworthiness authority for the military modifications. Doing so controls cost, risk, and acquisition time, while still meeting the performance requirements of the mission.

2.   Challenges and Lessons Learned

The approach of using the current aircraft's airworthiness authority to the maximum extent possible for the military modifications is atypical of military acquisition. While AIR-4.0P acknowledges and accepts FAA airworthiness certifications (Airworthiness and CYBERSAFE Directorate [AIR-4.0P] 2016), deliberate use of the FAA to assess military modifications is unfamiliar territory for most of NAVAIR. NAVAIR is assessing only those airworthiness areas the FAA cannot or will not, due to lack of or explicit conflict with civil regulations. Refreshers of this fundamental premise in the VH-92A's acquisition strategy are required regularly. Lack of familiarity and natural turnover in personnel require education on FAA processes on a frequent basis. The program frequently corrects assumptions of a return to full NAVAIR airworthiness certification as the acquisition program continues. The perception of a loss of control requires re-assurance.

The difference between airworthiness and performance assessments affirms NAVAIR authorities' role in this program's acquisition. While the FAA is assessing airworthiness in the vast majority, NAVAIR is still assessing all requirements for verification of performance. The challenge here is to understand how the FAA airworthiness certification process assesses any given requirement in order to take advantage by not repeating effort. Full awareness, understanding, and engagement by NAVAIR during this process maximizes program efficiency, allowing acceptance of performance requirements during the FAA airworthiness certification process and reducing test efforts for performance verification.

Limiting SETR scope to only integration of new and modified design efforts reinforces the premise of accepting the existing aircraft design capabilities and its original airworthiness assessment. The performance of the modified aircraft as a whole is still paramount. Integration impacts are fully assessed, but without re-evaluation of the baseline S-92A against NAVAIR standards.

Requirements verification planning identifies what efforts, analyses, tests, and documents are necessary. Identification of when these products are available during execution of the program leads to a timeline and the representative S-curve shown in Figure

21. Notice the curve begins at sixty; the baseline S-92A aircraft itself satisfies some of the VH-92A system level requirements. The majority of requirements are verifiable by the time of the FAA TC release, 456 out of 677, or 67%. The TC release also marks the end of the contractor test (CT) period. The orange area identifies these verifiable requirements by the time of the TC release; this encompasses all verification methodologies, inclusive of analysis, inspection, demo, and test. The blue area identifies the remainder of requirements verification, beginning post-TC with the government integration test (IT) period.
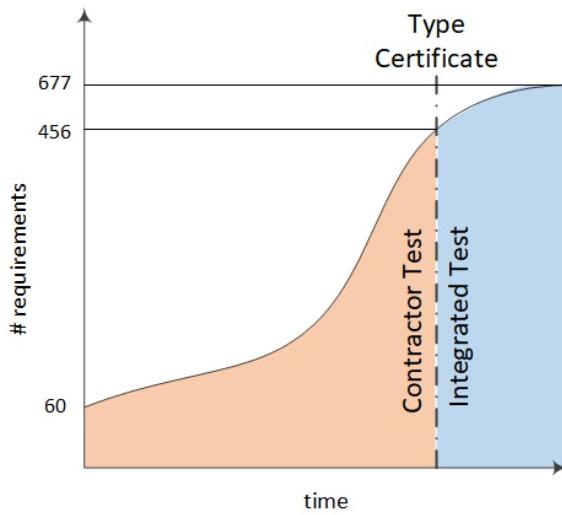

Figure 21.   Requirement Verification over Time

Recalling Figure 2, NAVAIR versus FAA requirements Venn diagram, Figure 22 draws a correlation to Figure 21 with matching colors. Between the normal execution of the program and the deliberate efforts to achieve an FAA TC, many requirements are verifiable by the time of the TC release; the orange area of requirements verifiable prior to TC relates to the orange area of the FAA airworthiness set. The blue post-TC area relates to the blue areas of the NAVAIR airworthiness and performance sets that protrude outside the FAA airworthiness set, or the complement of those sets with the FAA airworthiness set.

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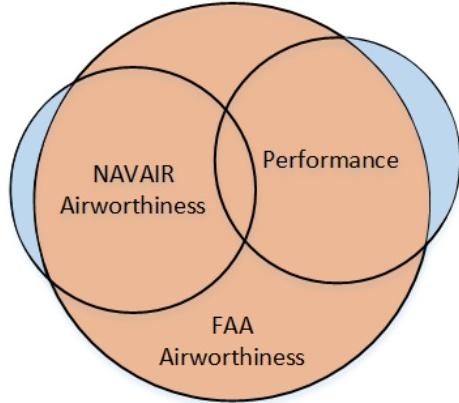
Figure 22. NAVAIR vs. FAA Venn Diagram, Pre- and Post-TC

In a typical military acquisition program, CT does not have the goal of achieving a civil airworthiness certificate, an FAA TC, prior to delivery to the government. The TC line of Figure 21 is then no longer a TC line, becoming instead a contractual definition delineating when CT ends and IT begins. This line shifts to the left, and typically, IT conducts a large amount of requirement verification effort. In the VH-92A program, Sikorsky will be verifying the majority of requirements, 67%, as a side benefit of pursing the FAA TC. Understanding execution details is critical to maximizing efficiencies and the ability to scope government IT to the minimum required effort.

This also leads to the challenge of assessing TRR and FRR at the appropriate time. TRR is held as needed for incremental and system level test preparation. System-level TRR and FRR, prior to the beginning of government IT, support requirement verification efforts. In the VH-92A program, understanding the test efforts conducted during CT in support of the FAA TC release and what the TRR and FRR SETR events evaluate requires a paradigm shift, evaluating appropriate content during CT and prior to the beginning of IT.

B. APPLICATION OF THESIS

This section re-evaluates the SETR timeline to FAA TC process comparison for the VH-92A program. After checking this analysis for validity with the VH-92A program, this section then discusses the mapping diagrams for TRR, FRR, FCA, and SVR. The author then discusses the benefits of this thesis work for the VH-92A program.

1. SETR Timeline to FAA TC Process for the VH-92A Program

The VH-92A program entered post Milestone B, with the release of the EMD contract in 2014 (NAVAIR 2016b). This leads to a shift in the alignment of the two timelines; the entire FAA TC process now executes during the EMD phase, see Figure 23. The SETR events also shift to align with contract award execution. The FAA TC process must complete prior to the completion of the EMD phase to allow for government IT execution and full assessment of the entire program at FCA and SVR, in support of Milestone C.

Notice the pre-flight TCBM still correlates to FRR in its purpose, but the program-level FRR must now align with the end of the FAA TC process, assessing the program's readiness to move into government IT. Remember TRRs occur as needed, prior to testing in the data generation phase and often held in conjunction with FRR prior to IT.
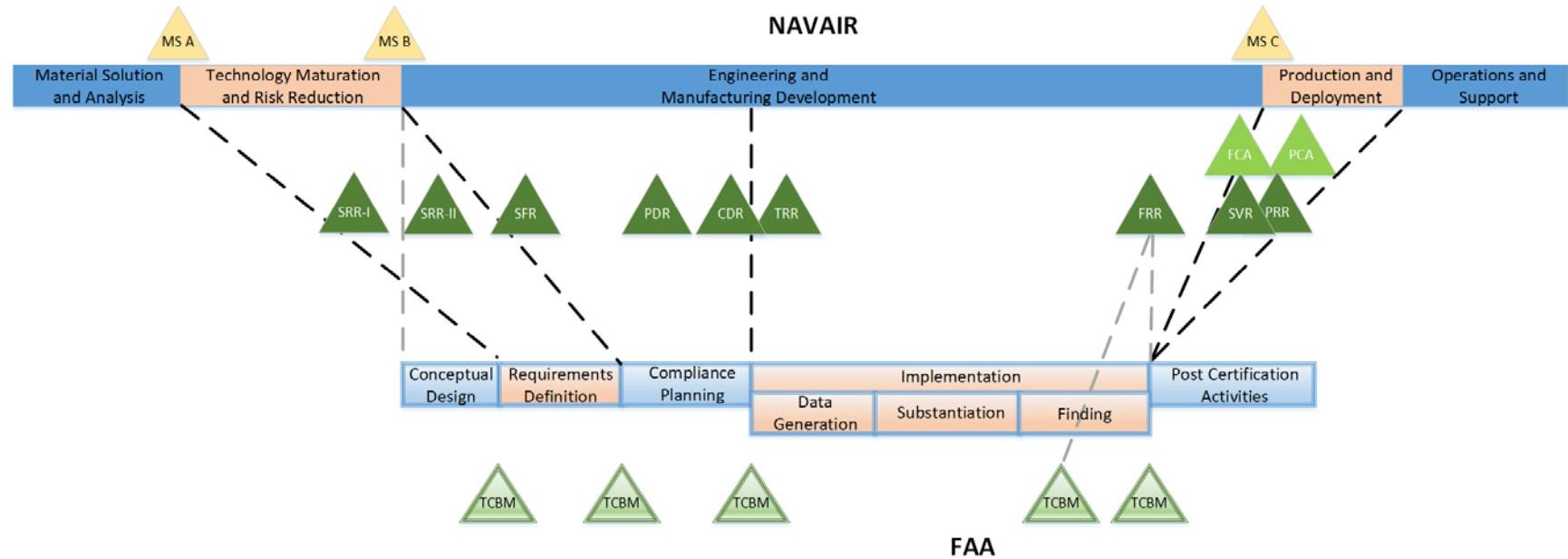
Figure 23.   NAVAIR SETR to FAA TC Process Comparison for VH-92A

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While the FAA TC process phase counterparts on the NAVAIR acquisition timeline remain the same for reasons previously discussed, the goal of this analysis is to map FAA TC process phases to SETR events. Since the SETR events have also shifted, the FAA element mapping to SETR events is unchanged.

2. TRR, FRR, FCA, SVR SETR Entrance Criteria Mapping to FAA Elements for VH-92A

The diagrams mapping of TRR, FRR, FCA, and SVR entrance criteria to FAA elements apply unchanged to this program. The challenge will be to obtain access to the referenced documents within the bounds of the contract since the FAA cannot provide them directly, and assess missed opportunities for efficiencies where there are gaps.

3. Benefits of the Analyses for the VH-92A

The timeline comparison provides a tool for education of FAA processes and alignment to NAVAIR acquisition and SETR for this program. Awareness and understanding of the differences and similarities is important to maximize further the benefits of executing a CDA program.

The high percentage of requirements verified during execution of the FAA TC process, 67%, is proof of execution efficiency opportunity. The identification of FAA elements mapped to SETR entrance criteria provides great potential in reducing evaluation effort, especially given the high requirement verification percentage. Understanding the work undergone in the FAA TC process allows the government to be aware of and engaged prior to its execution, gaining efficiencies by avoiding duplication of that work later, saving test efforts and therefore saving time and cost. The amount of savings is unquantifiable, as programmatic pressures and the already-defined contract may reduce the maximum potential benefits during execution, but the potential for avoidance is clear. The execution of TRR and FRR will benefit by this understanding and involvement. FCA and SVR can leverage a great deal of requirements verification executed by the FAA. By knowing what documents to review, for a given entrance criteria, the government can accept efforts already performed and documented for the FAA.

C.   CHAPTER SUMMARY

The Presidential Helicopter Replacement Program is a relevant case study for the focus of this thesis, a CDA program implementing SETR. The basics of the program's history and the VH-92A's acquisition strategy lead to a discussion on some challenges and lessons learned in the early stages of execution. The majority of requirements for this program, 67%, are verifiable by the time of the FAA TC release. The FAA elements to SETR entrance criteria mapping remains unchanged, verifying their applicability and benefits to this program. The high requirement verification percentage ensures the SETR entrance criteria mapping provides great potential in reducing the effort of evaluation.

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter draws conclusions, reviews the research questions, and provides recommendations for further work.

A. CONCLUSIONS

While the FAA elements cannot completely satisfy any given NAVAIR SETR entrance criteria due to NAVAIR SETR assessing a much broader scope, there is no question of benefit. For TRR, eight out of eleven entrance criteria mapped to FAA elements; for FRR, seven out of ten; for FCA, four out of five; and for SVR, three out of four. See Figure 24. Out of 30 evaluated SETR entrance criteria, 22 map to FAA elements; this is over 73%. This high ratio proves there is benefit in accepting FAA processes and documentation for military CDA programs, even with FAA elements providing partial satisfaction to the SETR entrance criteria.
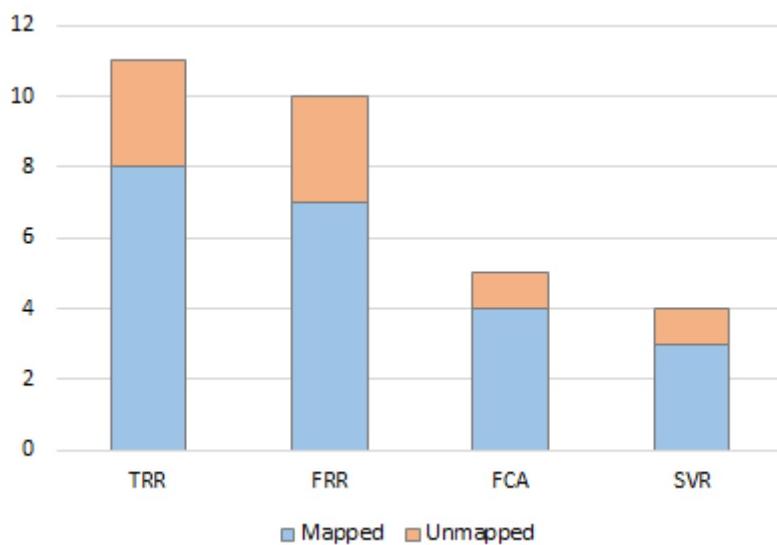

Figure 24.   Count of TRR, FRR, FCA, SVR Entrance Criteria Mapped to FAA Elements

Although cost and time to execute savings cannot be quantified, it is clear to see there is room for savings due to the high number of SETR entrance criteria mapped. No

two programs are the same, and each may have different amounts of performance requirement verification outside of the FAA airworthiness boundary. In the Presidential Helicopter Replacement Program case study of Chapter IV, approximately 67% of requirements will be validated thru the FAA TC process, ensuring benefits from the SETR entrance criteria mapping, if program execution allows.

Identification and referencing FAA processes is very helpful to NAVAIR education and recognition of efficiencies in a military CDA program. Training would improve the likelihood of implementing these benefits. Adding references within NAVAIR instructions and acknowledging specific FAA elements would support acceptance of commercial processes. This also would assist in knowing what deliverables to request when writing a contract, since the FAA cannot provide anything direct to the government.

B.   REVIEW OF RESEARCH QUESTIONS

The goal of this thesis is to create a mapping of FAA process and documentation to NAVAIR SETR events and their event criteria. This enables military CDA programs to reduce SETR and program execution effort by acknowledging and accepting the FAA elements instead of requiring duplicative effort to NAVAIR standards. Recalling the research questions of Chapter I:

- What is the benefit to NAVAIR SETR execution on CDA programs by considering FAA processes and documentation?

- For requirements verification planning, how do FAA processes and documentation for test readiness and flight readiness map to NAVAIR SETR Test Readiness Review (TRR) and Flight Readiness Review (FRR) entrance criteria?

- For requirements verification acceptance, how do FAA performance evaluations map to NAVAIR SETR Functional Configuration Audit (FCA) and System Verification Review (SVR) entrance criteria?

This thesis achieved its goal by comparing the NAVAIR SETR timeline to the FAA TC process at a high level, and then by mapping FAA elements to TRR, FRR, FCA, and SVR entrance criteria at a detail level. These four SETR events focus on requirement verification planning and evaluation, where the majority of the FAA TC process effort aligns with NAVAIR SETR efforts. This thesis answers these research questions with the

SETR entrance criteria to FAA element mapping diagrams, and demonstrates there is a significant savings potential by doing so in the Presidential Helicopter case study.

C. RECOMMENDATIONS

As discussed in Chapter I, the NAVAIR SETR process does not acknowledge commercial documentation generated in pursuit of a civil airworthiness certificate for military CDA programs. This is a missed opportunity, an additional benefit to the reduced costs and execution time of using commercial products and processes in a military acquisition. The NAVAIR airworthiness authority accepts FAA airworthiness products without further review, but the NAVAIR SETR process does not acknowledge FAA products in any manner.

Update and reinstate NAVAIRINST 13100.15 to renew NAVAIR's acknowledgement of commercial processes in SETR evaluations on CDA programs, potentially in the manner of this thesis. Avoid the use of "program points," which are not used by the FAA or NAVAIR. Ensure proper references to FAA documentation to enable education of commercial process details. Link to this instruction from within NAVAIRINST 4355.19 for SETR execution, or incorporate within NAVAIRINST 4355.19 itself. This would provide awareness of commercial terms, documentation, and processes for use in CDA program execution.

Cross-reference MIL-HDBK-516, explicitly for airworthiness certification criteria, to the JSSGs, for performance requirement development. These two documents do not reference each other, but NAVAIR uses both for requirement development. Providing a unified document would consolidate potential conflicts, redundancies, and could identify a requirement's purpose as airworthiness only, performance only, or performance affecting airworthiness. This would provide clarity when NAVAIR is planning for airworthiness assessments and scoping test efforts. An additional recommendation is to map also the MIL-HDBK-516 and JSSG requirements to those of the 14 CFR. This would enable potential alignment of the military CDA program requirements to 14 CFR requirements during requirement development; this would also enable benefit military CDA programs in knowing specifically which requirements the FAA would assess for a TC.

There are additional SETR events that could also benefit from mapping FAA processes and documentation, as identified in the timeline analysis of Chapter III. Completing the entrance criteria mapping effort for SRR-II, SFR, PDR, CDR, and PCA would identify similar benefits to those events as well.

APPENDIX. 4355.19 TRR, FRR, FCA, SVR ENTRANCE CRITERIA

NAVAIRINST 4355.19 contains the full entrance criteria for all SETRs. This appendix provides a ready listing of the entrance criteria for the four SETRs discussed in this thesis (NAVAIR 2015b).

A.   TRR ENTRANCE CRITERIA

1. System Requirements, Traceability and Design
     a. The current design reflects the product baseline.
     b. System technical interfaces (including external interfaces) have been updated and documented
     c. Traceability from design requirements to verification plan is complete and has been updated
     d. Subsystem level safety and hazard analysis supports the product baseline
2. Test, Evaluation and Certification of Product
     a. Test plans are ready for final review
     b. Test procedures are updated and address Acceptance Test Procedures (ATP); data collection, reduction, analysis; test and deficiency reporting
c. Coordination of test facilities is complete and facilities are available for testing
d. SIL V&V completed, results are documented, and the SIL is under CM control
e. Certifications and/or flight approvals have been obtained
f. CSI and CSA testing is complete and documented
g. Analysis of the current design verifies conformance to the product baseline
3. Project Management and Execution (Planning, Assessment and Control)
     a. Maturity of the CTEs are in accordance with the TMP
     b. Planning for IPS elements is current and supports the baseline
     c. Earned Value data reflects current program status
     d. CARD and/or cost estimates are up to date
     e. The IMS with critical path reflects current program status
     f. Program execution risks (programmatic and technical) are identified, and mitigation plans in place

B.   FRR ENTRANCE CRITERIA

1. System Requirements, Traceability and Design
     a. The current design reflects the product baseline
     b. Traceability from design requirements to verification plan is complete and has been updated
2. Test, Evaluation and Certification of Product
     a. Test plans have been drafted, are in the approval cycle, and ready for Executive Review Board
     b. Flight test requirements supporting M&S validation are identified

c. Test procedures have been updated and address ATP, data collection, reduction, analysis, test and deficiency reporting

d. Coordination of test facilities is complete and facilities are available for testing

e. Certifications required for flight testing are in place

f. Interim Flight Clearance to support flight test is in place

g. CSI and CSA testing is complete and documented

h. The design has been tested against the functional requirements

3. Project Management and Execution (Planning, Assessment and Control)

a. Maturity of the CTE are in accordance with the TMP

b. Planning for the IPS elements is current and supports the baseline

c. Earned Value data reflects current program status

d. CARD and/or cost estimates are up to date

e. The IMS with critical path reflects current program status

f. Program execution risks (programmatic and technical) are identified, and mitigation plans in place

g. CDRL and data requirements are up to date

C. FCA ENTRANCE CRITERIA

1. System Requirements and Capabilities

a. The physical system reflects the functional baseline

b. Traceability from design and functional requirements to verification plan is complete and has been updated

2. Test, Evaluation and Certification of Product

a. Engineering data artifacts have been reviewed and demonstrates compliance with the functional baseline

b. Project Management and Execution (Planning, Assessment and Control)

c. CM procedures are up to date and address program needs

D. SVR ENTRANCE CRITERIA

1. System Requirements and Capabilities

Traceability from design and functional requirements to verification plan is complete and has been updated

2. Test, Evaluation and Certification of Product

a. Current test Results and remaining tests planned have an acceptable level of risk

b. Certifications required for fielding are in place or will be in place by Initial Operation Capability

c. Permanent Flight Clearance (PFC) in the form of Preliminary Naval Aviation Training and Operating Procedures Standardization (NATOPS) and Naval Aviation Technical Information Product (NATIP) (or equivalent) to support operational flight test is in place

3. Project Management and Execution (Planning, Assessment and Control)

a. The Risk Management process is operating across the program, including contractor and government activities

b. CSI and CSA are identified, documented and are being managed

c. Planning for IPS elements is current and supports the baseline

d. CDRL and data requirements are up to date

e. Product baseline is producible as defined by Manufacturing, Producibility and Quality requirements as verified by the results of the IPRR

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